FIELD DEMONSTRATION REPORT

on

RECYCLING SPENT SANDBLASTING GRIT INTO ASPHALTIC CONCRETE

VOLUME I

FIELD DEMONSTRATION TEST METHODS, RESULTS, AND CONCLUSIONS

to

Naval Facilities Engineering Services Center
Port Hueneme, California

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by

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ACRONYMS AND ABBREVIATIONS

ABR	approximate bitumen ratio
ASTM	American Society for Testing and Materials
BAAQMD	Bay Area Air Quality Management District
Caltrans	California Department of Transportation
CAL WET	California Waste Extraction Test
CAM	California Assessment Manual
CARB	California Air Resources Board
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CKE	centrifuge kerosene equivalent
DBT	dibutyltin
DTSC	(California) Department of Toxic Substances Control
EPA	Environmental Protection Agency
EP Tox	extraction procedure toxicity
GC	gas chromatography
GCAPCD	Glenn County Air Pollution Control Division
GC/MS	gas chromatography/mass spectrometry
HPA	Hunters Point Annex
HSC	Health and Safety Code
ICP	inductively coupled plasma
MBT	monobutyltin
MDL	method detection limit
MINIRAM	miniature real-time aerosol monitor
NOSC	Naval Ocean Systems Center
OSHA	Occupational Safety and Health Administration
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCF	pound per cubic foot
QC	quality control
R&D	research and development
RCRA	Resource Conservation and Recovery Act

SAE	Society of Automotive Engineers
STLC	(California) Soluble Threshold Limit Concentration
SVOC	semivolatile organic compound
TBT	tributyltin
TCLP	Toxicity Characteristic Leaching Procedure
TLV	threshold limit value
TTLC	(California) Total Threshold Limit Concentration
TWA	time-weighted average
VOC	volatile organic compound
WESTDIV	Western Division
WET	Waste Extraction Test

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VOLUME I – FIELD DEMONSTRATION TEST METHODS, RESULTS, AND CONCLUSIONS

1.0 INTRODUCTION

This field demonstration report describes a full-scale field demonstration of recycling spent sandblasting grit from Hunters Point Annex (HPA). The report discusses characterization and testing leading up to the demonstration, activities performed in the demonstration, results of the demonstration, applicability of the recycling process to other sites, and lessons learned during the project.

1.1 Purpose of the Project

The field demonstration was performed to collect data about a process to recycle spent silica sandblasting grit as part of the aggregate in forming asphaltic concrete. "Asphaltic concrete" is a mixture of a bituminous thermoplastic polymer used as cement with graded aggregate to form a flexible paving material. Asphaltic concrete is also called "bituminous paving" and in common terms is often shortened to "asphalt." The field demonstration program was structured to collect data on process operations, product performance, and costs for conducting grit recycling at a commercial scale. The data are used to determine the effectiveness, implementability, and cost of the recycling option in the field demonstration and evaluate the potential for application of recycling of grit and other similar wastes by using them as aggregate in asphaltic concrete.

The recycling option takes advantage of favorable physical characteristics of the grit to allow the spent grit to function as a component in asphaltic concrete. Recycling of the grit reduces reliance on disposal or treatment and disposal as waste management options.

1.2 Scope of Project

All project activities were conducted using a silica sand spent sandblasting grit. The total amount of spent sandblasting grit used in the full-scale field demonstration was 4,665 tons, as determined from actual truck load weights. The grit used in the demonstration program has been the subject of an ongoing investigation by the U.S. Navy and Battelle Memorial Institute for several years. The grit consisted of two piles deposited on the industrial landfill area of the shipyard. The larger pile was about 3,200 yd^3 of spent abrasive remaining from ship cleaning operations. A smaller 800 yd^3 pile was created as the result of a partially successful treatability test of a chemical stabilization process. The spent grit is not a Resource Conservation and Recovery Act (RCRA) hazardous waste but was hazardous waste in California due to Soluble Threshold Limit Concentration (STLC) leachability of lead and copper.

The field demonstration project was the culmination of a series of projects studying environmentally responsible methods to manage spent sandblasting grit. The full-scale demonstration was preceded by sampling and analysis, bench-scale treatability studies, a pilot-scale test, and an air emissions risk assessment. These earlier activities will be described to provide a basis for the more detailed discussion of the test methods and results in the full-scale demonstration. The sequence of major events accomplished by this series of projects is summarized in Table 1-1. Papers published as a result of the project work are included in Appendix A.

1.3 Organization of Report

The report provides a comprehensive background on the characterization, regulatory compliance activities, and preliminary testing to document the framework for the field demonstration. The information is presented in two volumes. Volume I describes the activities, results, and conclusions related to testing activities. Volume II is a technology transfer manual describing the lessons learned in the field demonstration in the form of a "how-to" manual for recycling spent sandblasting grit.

Volume I starts with a summary of contaminant concentration and matrix properties in Section 2.0. Regulatory compliance activities are described in Section 3.0. The methods and results of bench-scale treatability testing are described in Section 4.0. Section 5.0 discusses grit pretreatment, asphalt manufacture, and preparation of test strips for a long-term pilot-scale test. The results of the pilot-scale testing including air monitoring during excavation and screening of spent sandblasting grit, chemical and physical testing of samples taken from the test strips, compliance of leaching tests with regulatory criteria, and results of a test of grinding the test strip are given in Section 6.0. These summaries of prior testing activities are supplemented with extensive backup detail in appendices.

The activities involved in the field demonstration are then described. Section 7.0 discusses preparation of asphalt at a commercial asphalt plant for the full-scale field demonstration and the test methods used in the field demonstration. The results of the field demonstration are described in Section 8.0. The advantages and limitations, lessons learned, and potential for technology transfer to other sites are briefly summarized in Section 9.0. The references are listed in Section 10.0.

Volume II provides a step-by-step guide to planning and performing a program to recycle spent sandblasting grit. This technology transfer volume discusses characterization of spent grit (Section 2.0), regulatory considerations (Section 3.0), asphalt mix design (Section 4.0), work plan development and contracting procedures (Sections 5.0 and 6.0), typical costs for grit recycling (Section 7.0), the advantages and disadvantages of recycling spent grit as asphalt aggregate (Section 8.0), and the references used to prepare Volume II (Section 9.0).

Table 1-1. Summary of Major Project Events

Date	Activity	Comments
11/88	Performed sampling of spent grit pile as part of sulfide stabilization test	Provided characterization data for untreated grit
11/89	Field test of sulfide stabilization	Unable to completely reduce California Waste Extraction Test (CAL WET) leaching of Pb and Cu to regulatory levels. Resulted in 3,200 yd^3 untreated pile and 800 yd^3 sulfide-treated grit pile
1/91	Initial asphalt treatability test	Tested 46% and 7% grit mixtures and determined 7% grit could reliably pass CAL WET test
11/91	Placed pilot-scale asphalt test strips and collected first core samples	Samples taken indicated good leach resistance and physical properties
6/93	Collected second core samples from pilot-scale test strips	Samples taken indicated good leach resistance and physical properties
7/93	Road surface milling test with pilot-scale strips	Measured low lead and copper levels in air emissions during scarification to simulate road surface renewal process
2/94	Identified Jaxon, Inc., Orland, CA hot-mix asphalt plant as site for full-scale test	
	Treatability test using Jaxon's bitumen	Tested 5% grit mixture and passed CAL WET
6/94	Collected third core samples from pilot-scale test strips	Samples taken indicated good leach resistance and physical properties
	Full-scale screening of grit and debris crushing	Material preparation for full-scale test
	Start of full-scale asphalt production/grit recycling demo	Samples taken indicated good leach resistance and physical properties
10/95	Completion of full-scale asphalt production/grit recycling demo	Samples taken indicated good leach resistance and physical properties

2.0 INITIAL CHARACTERIZATION

This section describes the characterization of the spent sandblasting grit performed in preparation for the testing of recycling the grit as asphalt aggregate.

2.1 Site Description

From 1976 to 1986, the U.S. Navy leased most of its naval station, Treasure Island, Hunters Point Annex (HPA), to Triple A Machine Shop, which operated it as a commercial ship repair facility (see Figure 2-1). Triple A's shipyard corrosion control operations generated waste sandblasting grit, which was deposited in the industrial landfill area of the shipyard. An approximately 4,000-yd^3 pile of waste sandblasting grit present at the facility is the main source of material for the treatability studies, pilot-scale testing, and full-scale demonstration discussed in this Field Demonstration Report. A portion of the initial pile was used for a test of a chemical stabilization treatment of the spent grit. The treatment test occurred in December 1989 and consisted of treating about 800 yd^3 of spent grit with small additions of fly ash, sodium hydrosulfide, and water. The treatment did not completely stabilize the leachable lead and copper resulting in two spent grit types: (1) a larger pile of untreated grit and (2) a smaller pile of sulfide-treated grit. Thus, the main source for test material from HPA consists of two piles, an approximately 3,200 yd^3 pile of untreated grit and an approximately 800 yd^3 pile of grit that was treated using the chemical stabilization procedure with small amounts of fly ash, sodium hydrosulfide, and water in December 1989. The 3,200 yd^3 pile of grit has not been treated and is henceforth referred to as "untreated grit" (see Photo 2-1). The 800 yd^3 pile of sulfide-treated grit is henceforth referred to as "sulfide-treated grit." This terminology is used to distinguish the grit sources used for the recycling tests from the "asphalt-treated grit," which is the term that will be used in this work plan for the asphaltic concrete prepared using HPA grit as a portion of the aggregate.

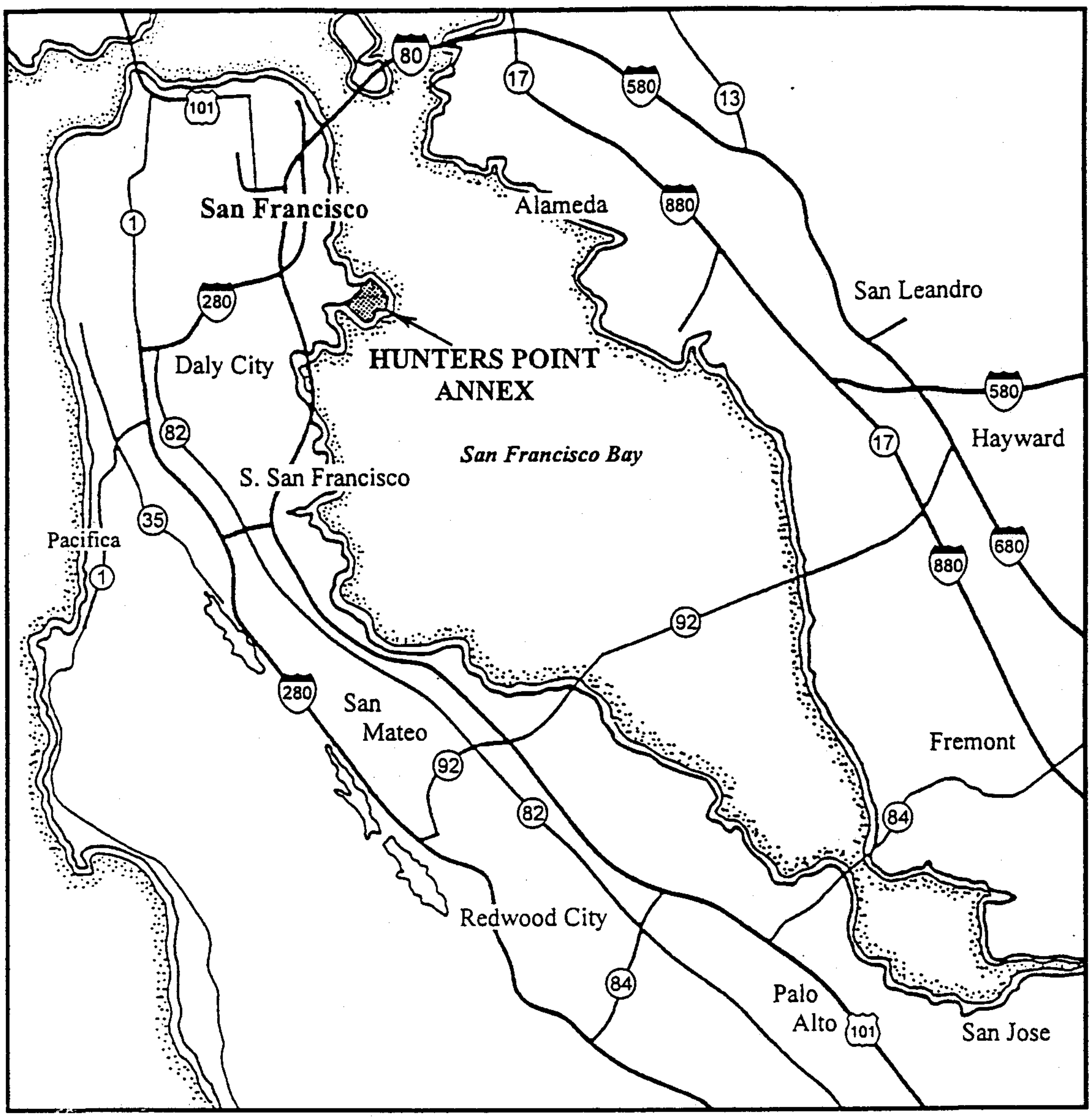
In addition, about 245 tons of grit were collected from eight small piles located around HPA. The site number, approximate amount of grit, and site description are shown in Table 2-1. The grit at Building PA44 was sampled on June 28, 1993. The other locations were sampled on March 15, 1994. All of the piles were collected by vacuum truck and screened during the full-scale field demonstration in June 1994.

2.2 Sampling and Analysis

Both the initial grit and the sulfide-treated grit have been extensively characterized chemically, based on statistically designed sampling and analysis methodology, as described in Means et al. (1991a, b). The types of analyses that were performed include the following:

- Total metals content (acid-digestible metals content for comparison with California Title 22 TTLC (Total Threshold Limit Concentration) for the 17 CAM (California Assessment Manual) metals plus hexavalent chromium.

- California WET (Waste Extraction Test) soluble metal content for metals having the potential of exceeding their Title 22 STLC (Soluble Threshold Limit Concentration) values based on the TTLC data.



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DESIGNED BY J.M.	Location of Hunters Point Annex in the San Francisco Bay Area	
DRAWN BY V.S.	PROJECT HUNTERS POINT PROJECT	
CHECKED BY L.S.	PROJECT NUMBER G283201-FRIA	DATE 11/95

Figure 2-1. Location of Hunters Point Annex

Photo 2-1. General area view of untreated grit pile.

- Extraction procedure toxicity (EP Tox) and Toxicity Characteristic Leaching Procedure (TCLP) leaching data for the 8 RCRA metals.

- Organic priority pollutant data on both the untreated grit and the sulfide-treated grit.

Table 2-1. Site Information for Additional Sandblasting Grit Wastes

Site #	Estimated Amount of Grit (tons)	Site Description
1	20	At PA26, west of Building 140
2	30	At PA31
3	2	Northeast of IR20
4A	100	At PA57, Hopper at drydock 4
4B	1	At PA57, south side of drydock 4
14	90	At PA44
17A	1	At IR14/15, green diamond-type grit
17B	1	IR14/15, beach sand-type grit

- Organo-tin analyses to test for the presence of butyltin antifouling compounds in the grit.

The analytical methods used are summarized in Table 2-2.

In addition, one sample was taken from each of seven of the eight small piles and analyzed for TTLC and STLC metals. Five samples were taken from the grit pile at PA44 and analyzed for TTLC, STLC, and TCLP metals and total fluoride. The results of the analyses of untreated and sulfide-treated samples are presented in detail in Means et al. (1991a, b). Compositional summaries for metal and organic contaminants are presented in Section 2.3. The result of a grain-size analysis to determine matrix suitability as asphalt aggregate is provided in Section 2.4.

2.2.1 Sampling and Analysis for Metals Characterization

In 1988, the original 4,000 yd^3 pile of untreated grit was the subject of an extensive characterization effort. The results from this initial characterization provide the most detailed evaluation of variations in grit properties and used methods similar to those used in later characterization efforts. Therefore, sampling and characterization of the initial pile for total leachable metals will be described in detail to indicate the sampling and analysis methods used throughout the project.

The initial pile consisted of an accumulated pile of sandblasting grit situated on a cleared soil area. The pile is approximately 18 m (20 yd) wide by 41 m (45 yd) long, in the approximate shape of a kidney bean, and is about 3 m (9 ft) high with a relatively flat top. The pile has been covered with a tarpaulin to reduce dust emissions and the infiltration of precipitation through the pile.

Because of possible variations in metal concentrations in different parts of the pile, samples were collected from random locations on the surface and at various depths. In November 1988 the pile was gridded into equal surface areas by marking a coordinate every 2 m (6 ft). This resulted in 208 grids having surface areas of approximately 4 m^2 (36 ft^2) each (see Figure 2-2). The grid areas were numbered consecutively so that sample locations could be referenced. Then sample grid numbers were selected from a random number table for each sampling location. Twenty-four different samples were collected along with two blind replicates. Eight locations were sampled at each of three depth intervals: (a) 0 to 1 m (0 to 3 ft, avoiding the top 8 cm or 3 in.); (b) 1 to 2 m (3 to 6 ft); and (c) 2 to 3 m (6 to 9 ft).

The sulfide-treated grit pile was located just east of the untreated pile, stored on a plastic ground liner, and covered with plastic to protect it against the weather. The pile was approximately 25 yards long by 15 yards wide and 2 to 4 feet deep. The sulfide-treated pile contained sandblasting grit that was treated with aqueous sodium hydrosulfide, fly ash, and water.

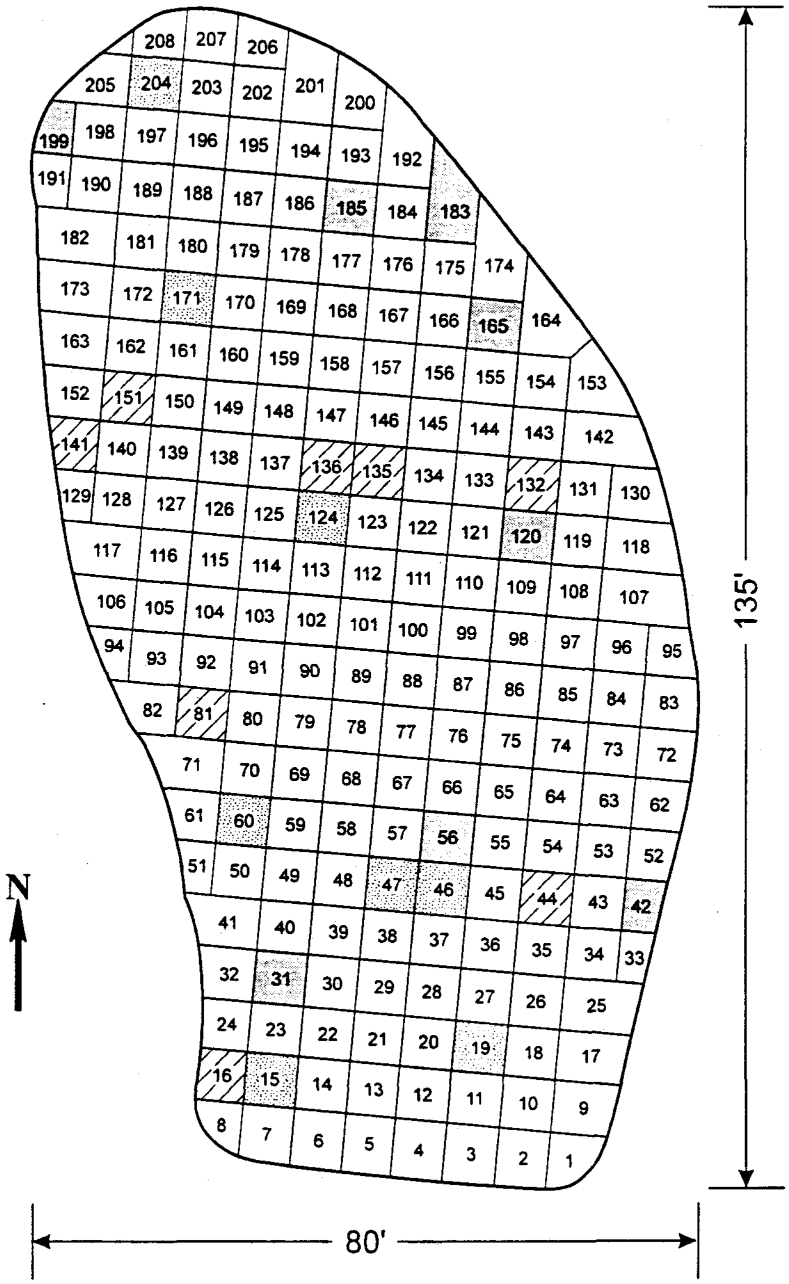
Samples were collected at varying depths and horizontal locations in the sulfide-treated pile. The sampling design for the treated material was a random grid design at two depths. Information on the variability of sample composition is necessary to ensure that the sampling reflects the actual composition of the entire 800 yd^3 of treated grit as closely as possible. Sixteen treated grit samples were collected.

Samples were collected using a stainless steel shovel for surface samples or a sand auger for depth samples (see Photo 2-2). A portion of each sample was archived for possible future use. Samples were split in the field using a riffle-type splitter, placed in precleaned polyethylene (I-Chem

Table 2-2. Methods Used for Chemical Analyses of Spent Sandblasting Grit

Extraction Methods	
TTLC – California Title 22 CCR 66699	
STLC – California Title 22 CCR 66699	
TCLP – EPA SW-846 Method 1311	
Analytical Methods for Metals	
Antimony	EPA SW-846 Method 7041
Arsenic	EPA SW-846 Method 7060
Barium	EPA SW-846 Method 7080
Beryllium	EPA SW-846 Method 7090
Cadmium	EPA SW-846 Method 7130
Chromium	EPA SW-846 Method 7190
Cobalt	EPA SW-846 Method 7200
Copper	EPA SW-846 Method 7210/6010
Lead	EPA SW-846 Method 7420/6010
Mercury	EPA SW-846 Method 7471
Molybdenum	EPA SW-846 Method 7480
Nickel	EPA SW-846 Method 7520
Selenium	EPA SW-846 Method 7740
Silver	EPA SW-846 Method 7760
Thallium	EPA SW-846 Method 7840
Vanadium	EPA SW-846 Method 7910
Zinc	EPA SW-846 Method 7950
Hexavalent chromium	EPA SW-846 Method 7196
Analytical Methods for Organics	
Volatile organics	EPA SW-846 Method 8240
Semivolatile organics	EPA SW-846 Method 3510/8270
Pesticides and polychlorinated biphenyls (PCBs)	EPA SW-846 Method 3510/8080
Butyltin	Naval Ocean Systems Center Method

Corp.) bottles, and immediately shipped under chain of custody to the appropriate laboratory for analysis or storage. The splitter, sampling devices, and mixing tray were cleaned between each sample. A field quality control (QC) blank was collected using clean sand to verify that cross-contamination was not occurring. Permanent field notebooks were maintained with proper documentation.



Surface Samples

Mid-Level Samples

Lower-Level Samples

NOT TO SCALE

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DESIGNED BY J.M.	**Sampling Locations at the Waste Pile**	
DRAWN BY V.S.	PROJECT HUNTERS POINT PROJECT	
CHECKED BY L.S.	PROJECT NUMBER G283201-FRIA	DATE 11/95

Figure 2-2. General Area View and Sampling Locations of Untreated Grit Pile

Grit samples were submitted for chemical and physical testing. A summary of the chemical analyses used is provided in Table 2-2. The regulatory limits for the TTLC, STLC, and TCLP are summarized in Table 2-3 to serve as a basis for establishing regulatory requirements for waste management.

2.2.2 Sampling and Analysis for Organic Characterization

One sample each of untreated and sulfide-treated grit was collected at random from the appropriate grit piles for organic analysis. Because both the treated and untreated grit piles are covered with a heavy, sealed plastic tarpaulin, samples for volatile organics analysis were collected at the same time that the tarpaulin was cut to remove material for the demonstration. Once the material for the field demonstration had been removed from the piles, samples for volatile organics analysis were collected using a stainless steel auger and were then transferred immediately from the auger into a glass sample container by means of a stainless steel spoon. Any headspace or air voids were eliminated while filling the sample container. The sample from the untreated pile was collected from the southeast end of the pile, at a depth of approximately 2.5 feet; the sample from the treated pile was taken from the northwest corner of the pile, at a depth of approximately 1 foot. All sample bottles were placed in polyethylene bags and then securely sealed after label information and sample identification were checked and entered on standard chain-of-custody forms. The samples were immediately shipped to a California-certified analytical laboratory, which performed the analyses with U.S. EPA holding times. Grit samples were analyzed for volatile organic priority pollutants using EPA Method 8240 (see Table 2-2).

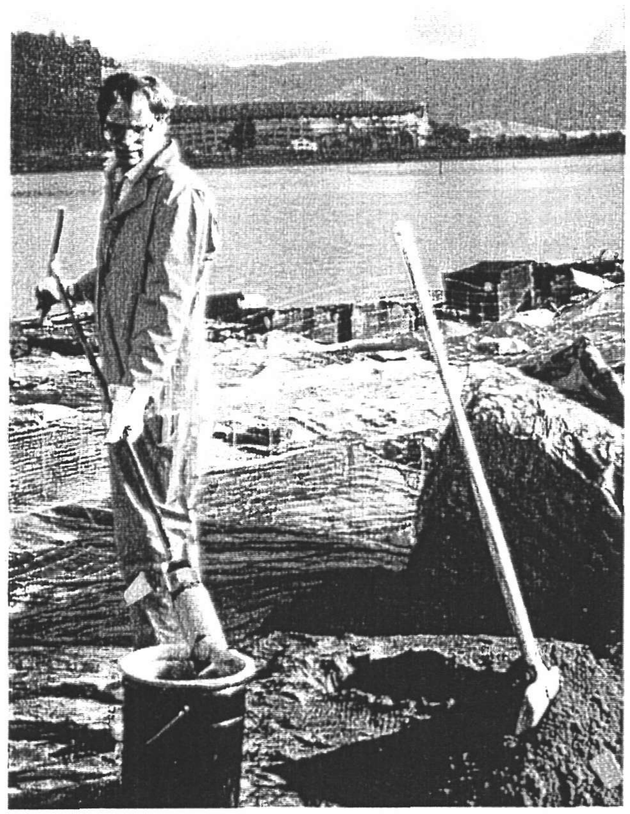


Photo 2-2. Using a sand auger to sample the spent sandblasting grit pile at Hunters Point Annex.

2.2.3 Sampling and Analysis for Debris Characterization

The untreated pile of spent sandblasting grit contains wood, cloth, and metal debris. These debris are not compatible with use as asphalt aggregate and thus would be separated and disposed of by a different waste management method. Analysis of total metals, WET leachable metals, and TCLP leachable metals in the debris is needed to determine the appropriate management method.

Composite grab samples of debris were collected from the edges of the untreated pile on two occasions. Three samples of wood, cloth, and metal were collected during the first sampling event (October 24, 1991) and three samples of cloth and four of wood were collected during the second sampling event (June 28, 1993). The samples were placed in cleaned sample bottles. The bottles

Table 2-3. Total and Soluble Metal Concentration Regulatory Thresholds

Element	TTLC[a] (mg/kg)	STLC[a] (mg/L)	TCLP[b] (mg/L)
Cu	2,500	25	–
Pb	1,000	5	5
Sb	500	15	–
As	500	5	5
Ba	10,000	100	100
Be	75	0.75	–
Cd	100	1	1
Cr (Total)	2,500	560	5
Cr(VI)	500	5	–
Co	8,000	80	–
Hg	20	0.2	0.2
Mo	3,500	350	–
Ni	2,000	20	–
Se	100	1	1
Ag	500	5	5
Tl	700	7	–
V	2,400	24	–
Zn	5,000	250	–

(a) From California Code of Regulations, Title 22, Section 66699
TTLC = Total Threshold Limit Concentration
STLC = Soluble Threshold Limit Concentration using the California Waste Extraction Test (CAL WET)
(b) Toxicity Characteristic Leaching Procedure (TCLP)
Federal Register, *55*(61):11804, Thursday, March 29, 1990.
Source: Means et al. (1991a).

were then labeled, placed in polyethylene bags, and shipped (with standard chain-of-custody forms) to the laboratory.

2.2.4 Sampling Minor Grit Accumulations

Samples were collected from eight small piles of spent sandblasting grit at various locations abound HPA (see Section 2.1). In all cases, the samples were collected as composite grab samples using a stainless steel shovel.

2.3 Contaminant Concentration and Leachability

This section describes the results of analyses of the total concentration and leachability of contaminants in the spent sandblasting grit.

2.3.1 Metal Composition Data

A summary of total metals concentration data is provided in Table 2-4 for both the untreated and sulfide-treated grits. Copper, lead, and zinc are the primary metal contaminants. Traces of

Table 2-4. Mean Metal Contents (TTLC Analysis) for Untreated and Sulfide-Treated Grit Samples

	Total Metal Concentration (mg/kg)		
Element	Untreated Grit	Sulfide-Treated Grit	TTLC Limit[a]
Cu	1,832	1,300	2,500
Pb	204	160	1,000
Sb	11	<20	500
As	5.4	1.5	500
Ba	246	160	10,000
Be	0.2	<0.6	75
Cd	<0.5	<1	100
Cr (Total)	99.8	34	2,500
Cr(VI)	11.2	<1	500
Co	8.2	9	8,000
Hg	<0.4	<0.1	20
Mo	11.6	<10	3,500
Ni	79	54	2,000
Se	<0.5	<0.1	100
Ag	1.3	<1.0	500
Tl	5.0	<6.0	700
V	22.1	<21.3	2,400
Zn	1,062	960	5,000

(a) From California Code of Regulations, Title 22, Section 66699.
TTLC = Total Threshold Limit Concentration.
Source: Means et al., 1993a, Table 1-1.

several other metals are also present. Comparison with the TTLC criteria in the right-hand column of Table 2-4 shows that the HPA grit is *not* TTLC-hazardous.

A similar summary of the CAL WET-soluble metals concentration data is provided in Table 2-5, again for both the untreated and sulfide-treated grits. Copper and lead exceed their

Table 2-5. Mean WET-Soluble Metal Contents (STLC Analysis) for Untreated and Sulfide-Treated Grit Samples[(a)]

Element	Soluble Metal Concentration (mg/L)		
	Untreated Grit	Sulfide-Treated Grit	STLC Limit[(b)]
Cu	**144**	**55.5**	25
Pb	**19**	**11.1**	5
Sb	NA	<1.0	15
As	0.06	0.11	5
Ba	6.8	2.3	100
Be	<0.03	<0.03	0.75
Cd	<0.06	<0.05	1
Cr (Total)	2.0	1.4	560
Cr(VI)	<1.0	<1.0	5
Co	<0.2	<0.2	80
Hg	<0.01	<0.01	0.2
Mo	<1.0	<1.0	350
Ni	1.0	1.2	20
Se	<0.01	<0.01	1
Ag	<0.05	<0.05	5
Tl	<0.3	<0.3	7
V	<1.0	<1.0	24
Zn	146	89	250

(a) Samples exceeding STLC are shown in bold type.
(b) From California Code of Regulations, Title 22, Section 66699.
STLC = Soluble Threshold Limit Concentration
NA = Not analyzed.
Source: Means et al., 1993a, Table 1-2.

respective STLCs for both the untreated and sulfide-treated grit. Therefore, the grits are considered hazardous in California. The STLC Cu and Pb contents of the sulfide-treated grit were significantly lower than the STLC Cu and Pb contents of the untreated grit (Means, 1991a, b).

Table 2-6 summarizes the TCLP and EP Tox data for the untreated and sulfide-treated grit. None of the metals exceed their TCLP thresholds; therefore, the waste is not a RCRA hazardous waste. It is only considered hazardous by virtue of STLC Cu and Pb exceedances and is referred to as a California-only hazardous waste.

Examination of the total metal composition variation among samples of untreated grit indicates the potential range of contaminant composition that the asphalt recycling process will need to accommodate. Data for the mean and 80% upper confidence limit are shown in Table 2-7. Source data showing results for all samples are compiled in Appendix B. For all metals, the 80% upper confidence limit is close to the mean, indicating that the metal contaminants are uniformly distributed. Comparison of copper and lead composition as a function of depth, as shown in Table 2-8 also shows no tendency for wide compositional variation at various depths.

Table 2-6. Mean TCLP- and EP Tox Soluble Metal Contents for Untreated and Sulfide-Treated Grit Samples

Element	Soluble Metal Concentration (mg/L)		
	Untreated Grit	Sulfide-Treated Grit	TCLP Limit[a]
Pb	1.11[a]	<0.5	5
As	<0.5	<0.5	5
Ba	<5	<5	100
Cd	<0.05	0.1	1
Cr	<0.5	<0.5	5
Hg	<0.02	<0.02	0.2
Se	<0.05	<0.05	1
Ag	<0.05	<0.5	5

(a) EP Tox value is 0.6 mg/L vs. an EP Tox limit of 5 mg/L.

Source: Means et al., 1993a, Table 1-3.

Results for leachable lead and copper as measured by the CAL WET procedure indicate stratification. As shown in Figure 2-3, both copper and lead appear to be more leachable in surface samples (3-inch to 1-foot depth) than in the samples taken from the 1 foot to 2.5 foot depth interval. Although the pile has been covered, weathering may have changed the chemical or physical form of the metal contaminants, causing the surface samples to be less leach resistant.

Grit accumulations from various locations on base that were collected using a vacuum truck (see Photos 2-3 through 2-5) and consolidated into a single pile for asphalt recycling were chemically analyzed for total and WET-soluble CAM metals (18 different analyses). Collection and consolidation occurred during the full-scale field demonstration in June 1994 (see Section 7.2). Grit at Building PA44 was sampled on June 28, 1993. Grit at the other locations was sampled on March 15, 1994. The averages of the results for the TTLC, STLC, and TCLP from 5 samples taken from the grit pile at Building PA44 are compared to the results for untreated grit in Tables 2-9, 2-10, and 2-11, respectively. Results for TTLC and STLC metals for the other seven sites are shown in Tables 2-12 and 2-13, respectively. In general the metals concentrations are consistent with the data collected by personnel from PRC, Inc. previously on this grit, i.e., metal concentrations are relatively low and compatible with the asphalt recycling option. The composite grit sample is coded

Table 2-7. Statistical Summary of Metal Analysis for Untreated Samples

Element	Total Concentration, mg/kg		
	Mean	Upper 80% Confidence Limit	TTLC Limit[(a)]
Cu	1,832	1,926	2,500
Pb	204	219	1,000
Sb	11	–[(b)]	500
As	5.4	6.0	500
Ba	246	277	10,000
Be	0.2	0.23	75
Cd	<0.5	–[(c)]	100
Cr (Total)	99.8	115.5	2,500
Cr(VI)	11.2	–[(d)]	500
Co	8.2	9.9	8,000
Hg	<0.4	–[(c)]	20
Mo	11.6	17.6	3,500
Ni	79	103	2,000
Se	<0.5	–[(c)]	100
Ag	1.3	–[(e)]	500
Tl	5.0	5.0[(c)]	700
V	22.1	25.4	2,400
Zn	1,062	1,330	5,000

(a) From California Administrative Code, Title 22, Section 66699.
TTLC = Total Threshold Limit Concentration
(b) One data point.
(c) All samples have concentrations below the detection limit.
(d) Only two data points.
(e) Only one data point above the detection limit.

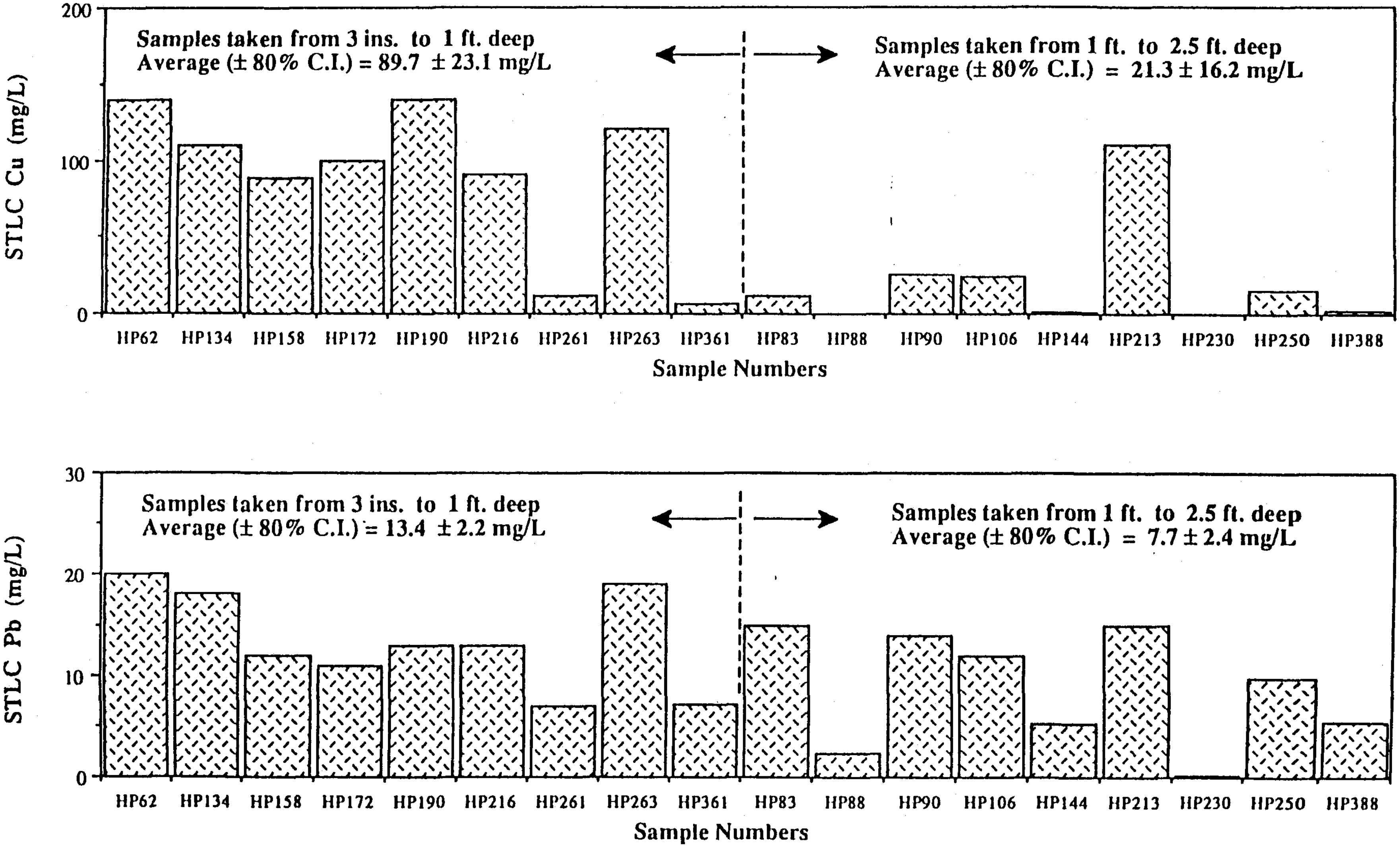
"VAC-CS-1" and is not a hazardous waste because it passes both the TTLC and STLC criteria, as shown in Tables 2-12 and 2-13.

2.3.2 Organic Contaminant Composition Data

With the exception of organometallic antifouling compounds, organic contaminants typically would not be associated with sandblasting wastes. However, the contaminants being cleaned from the ship surface might have included organics, or organics might have been added inadvertently to or spilled near the waste pile. Analyses for a wide range of organic contaminants, including volatile

Table 2-8. Cu and Pb Concentrations Versus Depth

		Total Cu (mg/kg)			Total Pb (mg/kg)		
Layers (ft)	No. of Samples	Mean Concentration Cu	Standard Deviation Cu	80% Upper Confidence Level Cu	Mean Concentration Pb	Standard Deviation Pb	80% Upper Confidence Level Pb
0-3	9	1,729	512	1,954	194	54.8	218
3-6	9	1,960	324	2,103	232	73.3	264
6-9	8	1,800	207	1,904	185	48.3	206



Source: Means et al., 1991a.

Figure 2-3. Graphical Representation of STLC Data From Treated Grit Pile as a Function of Sample Depth.

Photo 2-3. Collecting grit from inside Building PA44 with a vacuum truck.

Photo 2-4. Collecting grit outside Building PA44.

Photo 2-5. Interior view of Building PA44 after removal of the grit.

organic compounds (VOCs), semivolatile organic compounds (SVOCs), and pesticides and polychlorinated biphenyls (PCBs), were completed to establish a complete picture of a contaminant concentrations in the spent sandblasting grit. Results from the volatile organic contaminant analysis for untreated and treated grit are shown in Tables 2-14 and 2-15, respectively.

Several organic compounds were detected in low part-per-million concentrations, including traces of several PAHs (polyaromatic hydrocarbons), phthalates, PCBs, and volatile solvent-type compounds. However, the volatile organics analyses are suspect because the laboratory blank also contained trace levels of similar compounds (Means et al., 1991a).

The butyltin data included mono-, di-, and tributyltin compounds, which are frequently applied to ship hulls as antifouling compounds. The priority pollutant analyses are documented in Means et al. (1991b) and the butyltin analyses were completed by Naval Ocean Systems Center (NOSC). The results of the butyltin analysis on untreated spent grit are summarized in Table 2-16. The effects of heating and asphalt treatment on butyltin compounds are discussed in the treatability test section (Section 4.3).

2.3.3 Debris Contaminants

The first set of three samples of wood, cloth, and metal debris was taken on October 24, 1991 and was analyzed for WET-soluble and total Cu and Pb by a California-certified analytical laboratory. The results are shown in Table 2-17. The wood and the cloth appear to be California-hazardous, the wood based on STLC Pb exceedances in two of the three samples analyzed and the cloth based on STLC Cu and Pb and TTLC Cu exceedances. The average data on the steel debris indicated a

Table 2-9. Mean TTLC Metal Contents of the Grit from Building PA44 Compared to the Untreated Grit in Pile

Element	Total Metal Concentration (mg/kg)	
	PA44 Grit (average of 5 samples)	Untreated Grit
Cu	205	1,832
Pb	78	204
Sb	9.6	11
As	2.6	5.4
Ba	60.2	246
Be	<1.0	0.2
Cd	2.6	<0.5
Cr (Total)	142	99.8
Cr(VI)	0.01	11.2
Co	7.7	8.2
Hg	0.06	<0.4
Mo	7.1	11.6
Ni	285	79
Se	<0.5	<0.5
Ag	2.4	1.3
Tl	<20	5.0
V	12.2	22.1
Zn	392	1,062
F	2.9	NA

Source: Means et al., 1993b, Table 1-1.

nonhazardous classification. However, one sample showed a very slight TTLC Pb exceedance and another sample exhibited a very slight STLC Pb exceedance (Means et al., 1993a).

A second set of cloth and wood grab samples was collected on June 28, 1993 and analyzed to confirm the status of debris as hazardous waste (Means et al., 1993b).

Three grab samples of cloth debris from the untreated grit pile were analyzed for TCLP Pb. The results are presented in Table 2-18. Four grab samples of wood debris from the untreated grit

Table 2-10. WET-Soluble Metal Contents (STLC Analysis) of the Grit from Building PA44 Compared to the Untreated Grit in Pile

	STLC Leachable Metal Concentration (mg/L)	
Element	PA44 Grit (average of 5 samples)	Untreated Grit
Cu	8.7	144
Pb	6.4	19
Sb	0.56	NA
As	0.06	0.06
Ba	2.2	6.8
Be	<0.1	<0.03
Cd	0.18	<0.06
Cr (Total)	1.5	2.0
Cr(VI)	NA[a]	<1.0
Co	0.09	<0.2
Hg	<0.002	<0.01
Mo	0.3	<1.0
Ni	3.9	1.0
Se	<0.05	<0.01
Ag	<0.1	<0.05
Tl	<2.0	<0.3
V	0.06	<1.0
Zn	32.6	146
F	NA	NA

(a) Not analyzed, Cr(VI) not present in this grit (Table 2-9).
Source: Means et al., 1993b.

Table 2-11. Mean TCLP Soluble Metal Contents of the Grit from Building PA44 Compared to the Untreated Grit in Pile

	Total Metal Concentration (mg/L)	
Element	PA44 Grit (average of 5 samples)	Untreated Grit
Pb	1.0	1.11
As	<0.005	<0.5
Ba	0.61	<5
Cd	0.12	<0.05
Cr	0.13	<0.5
Hg	0.0004	<0.02
Se	<0.005	<0.005
Ag	<0.05	<0.05

Source: Means et al., 1993b.

Table 2-12. Results of Total Metals Analysis (TTLC) of Sandblasting Grit Samples Collected by Vacuum Truck from Different Locations at Hunters Point Annex[(a)]

Sample Number/ Site Number	Sample (values in mg/kg)									
	TTLC[(b)] NA	PA57H-1 4A	PA57H-2 4B	PA26-1 1	PA31-1 2	IR14/15-1 17A	IR14/15-2 17B	IR20-N-1 3	VAC-CS-1 Composite	Tarp Patches
Antimony	500	<1.2	<1.2	<1.2	2.6	<1.2	<1.2	5.6	<1.2	NA
Arsenic	500	2.4	2.3	<0.2	10	<0.2	<0.2	<0.2	<0.2	NA
Barium	10,000	71	100	8.8	4.4	8.0	14	44	26	NA
Beryllium	75	0.6	0.28	0.07	0.065	0.1	0.09	0.14	0.11	NA
Cadmium	100	1.8	2.4	<0.5	<0.5	<0.5	<0.5	2.8	1.5	NA
Chromium (Total)	2,500	9.4	42	22	5.9	97	34	58	24	NA
Chromium-VI	500	—	—	—	—	—	—	—	—	NA
Cobalt	8,000	13	18	1.5	1.9	6.0	1.7	4.9	2.2	NA
Copper	2,500	**460**	**880**	67	150	**2,000**	**2,700**	**720**	**350**	56
Lead	1,000	2.4	**200**	**57**	19	35	36	**420**	**89**	6.1
Mercury	20	0.067	0.074	<0.05	<0.05	<0.05	0.12	0.081	<0.05	NA
Molybdenum	3,500	7.6	<25	2.1	<0.25	3.2	<2.5	6.5	2.8	NA
Nickel	2,000	5.0	15	3.5	13	**390**	4.2	27	27	NA
Selenium	100	<0.5	<0.5	<0.5	<0.5	<5.0	<0.5	<0.5	<0.5	NA
Silver	500	2.0	1.9	1.2	1.6	2.0	2.1	1.8	1.7	NA
Thallium	700	<0.05	<0.05	<2.5	<0.05	<0.05	<0.05	<0.05	<0.05	NA
Vanadium	2,400	25	31	2.6	1.8	4.2	3.8	14	4.3	NA
Zinc	5,000	55	360	160	18	71	690	1,900	540	NA

(a) Total concentrations that could lead to exceeding the STLC limit are shown in bold.
(b) From California Administrative Code, Title 22, Section 66699.
TTLC = Total Threshold Limit Concentration.

Table 2-13. Results of Soluble Metals (WET Test) Analysis (STLC) of Sandblasting Grit Samples Collected by Vacuum Truck from Different Locations at Hunters Point Annex[(a)]

Sample Number/ Site Number	Sample (values in mg/L)								
	STLC[(b)]	PA 57H-1	PA 57H-2	PA 26-1	PA 31-1	IR 14/15-1	IR 14/15-2	IR 20-N-1	VAC-CS-1
Antimony	15								
Arsenic	5								
Barium	100								
Beryllium	0.75								
Cadmium	1								
Chromium (Total)	560							3.0	
Chromium-VI	5	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	0.019	0.022
Cobalt	80								
Copper	25	<0.2	<0.2			150	280	11.0	12
Lead	5		11	3.3		3.1		26.0	2.7
Mercury	0.2								
Molybdenum	350								
Nickel	20					5.9			
Selenium	1								
Silver	5								
Thallium	7								
Vanadium	24								
Zinc	250								

(a) WET test was only performed for those metals that had the potential for an STLC exceedance based on the total metals data (Table 2-12), taking into account the 10x dilution factor of the grit during the WET test. Consequently, a blank entry in this table indicates that an STLC exceedance was not possible.

(b) From California Administrative Code Title 22, Section 66699.

STLC = Soluble Threshold Limit Concentration.

Table 2-14. Untreated Grit Volatile Organic Compound Data

Parameter	Units	MDL	Concentration
Organic analysis — volatile organics, EPA Method 8240 GC/MS*			
Chloromethane	μg/kg	10	ND
Vinyl chloride	μg/kg	10	ND
Bromomethane	μg/kg	10	ND
Chloroethane	μg/kg	10	ND
Trichlorofluoromethane	μg/kg	5	ND
1,1,2-Trichlor-1,2,2-trifluoroethane	μg/kg	5	ND
2-Butanone (MEK)	μg/kg	50	ND
1,1-Dichloroethene	μg/kg	5	ND
Carbon disulfide	μg/kg	5	ND
Acetone	μg/kg	50	ND
Methylene chloride	μg/kg	5	ND
trans-1,2-Dichloroethene	μg/kg	5	ND
cis-1,2-Dichloroethene	μg/kg	5	ND
1,1-Dichloroethane	μg/kg	5	ND
Chloroform	μg/kg	5	ND
1,1,1-Trichloroethane	μg/kg	5	ND
1,2-Dichloroethane	μg/kg	5	ND
Carbon tetrachloride	μg/kg	5	ND
Benzene	μg/kg	5	ND
1,2-Dichloropropane	μg/kg	5	ND
Trichloroethane	μg/kg	5	ND
Bromodichloromethane	μg/kg	5	ND
trans-1,2-Dichloropropene	μg/kg	5	ND
4-Methyl-2-pentanone (MIBK)	μg/kg	50	ND
Toluene	μg/kg	5	11
cis-1,3,-Dichloropropene	μg/kg	5	ND
1,1,2-Trichloroethane	μg/kg	5	ND

Table 2-14. Untreated Grit Volatile Organic Compound Data (continued)

Parameter	Units	MDL	Concentration
Organic analysis — volatile organics, EPA Method 8240 GC/MS* (continued)			
Dibromochloromethane	μg/kg	5	ND
2-Hexanone	μg/kg	50	ND
Tetrachloroethane	μg/kg	5	ND
Chlorobenzene	μg/kg	5	ND
Ethylbenzene	μg/kg	5	ND
Bromoform	μg/kg	5	ND
Xylene(s) total	μg/kg	5	ND
Styrene	μg/kg	5	ND
1,1,2,2,-Tetrachloroethane	μg/kg	5	ND
1,3-Dichlorobenzene	μg/kg	5	ND
1,4-Dichlorobenzene	μg/kg	5	ND
1,2-Dichlorobenzene	μg/kg	5	ND
1,3-Dichloroethane-d4 (surrogate recovery)			93%
Toluene-d8 (surrogate recovery)			106%
4-Bromofluorobenzene (surrogate recovery)			94%

MDL = Method Detection Limit.
ND = Not detected at or above the MDL.
Laboratory: Pace Incorporated, Novato, California.
*EPA in this table refers to U.S. EPA procedures using gas chromatography/mass spectrometry (GC/MS).
Source: Means et al., 1993a, Table 2-3.

Table 2-15. Treated Grit Volatile Organic Compound Data

Parameter	Units	MDL	Concentration
Chloromethane	µg/kg	10	ND
Vinyl chloride	µg/kg	10	ND
Bromomethane	µg/kg	10	ND
Chloroethane	µg/kg	10	ND
Trichlorofluoromethane	µg/kg	5	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/kg	5	ND
2-Butanone (MEK)	µg/kg	50	ND
1,1-Dichloroethene	µg/kg	5	ND
Carbon disulfide	µg/kg	5	ND
Acetone	µg/kg	50	ND
Methylene chloride	µg/kg	5	ND
trans-1,2-Dichloroethene	µg/kg	5	ND
cis-1,2-Dichloroethene	µg/kg	5	ND
1,1-Dichloroethane	µg/kg	5	ND
Chloroform	µg/kg	5	ND
1,1,1-Trichloroethane	µg/kg	5	ND
1,2-Dichloroethane	µg/kg	5	ND
Carbon tetrachloride	µg/kg	5	ND
Benzene	µg/kg	5	ND
1,2-Dichloropropane	µg/kg	5	ND
Trichloroethane	µg/kg	5	ND
Bromodichloromethane	µg/kg	5	ND
trans-1,3-Dichloropropene	µg/kg	5	ND
4-Methyl-2-pentanone (MIBK)	µg/kg	50	ND
Toluene	µg/kg	5	9
cis-1,3-Dichloropropene	µg/kg	5	ND
1,1,2-Trichlorethane	µg/kg	5	ND
Dibromochloromethane	µg/kg	5	ND

Table 2-15. **Treated Grit Volatile Organic Compound Data (continued)**

Parameter	Units	MDL	Concentration
Organic analysis — volatile organics, EPA Method 8240 GC/MS* (continued)			
2-Hexanone	μg/kg	50	ND
Tetrachloroethane	μg/kg	5	ND
Chlorobenzene	μg/kg	5	ND
Ethylbenzene	μg/kg	5	ND
Bromoform	μg/kg	5	ND
Xylene(s) total	μg/kg	5	ND
Styrene	μg/kg	5	ND
1,1,2,2-Tetrachloroethane	μg/kg	5	ND
1,3-Dichlorobenzene	μg/kg	5	ND
1,4-Dichlorobenzene	μg/kg	5	ND
1,2-Dichlorobenzene	μg/kg	5	ND
1,2-Dichloroethane-d4 (surrogate recovery)			96%
Toluene-d8 (surrogate recovery)			104%
4-Bromofluorobenzene (surrogate recovery)			89%

MDL = Method Detection Limit
ND = Not detected at or above the MDL.
Laboratory: Pace Incorporated, Novato, California
*EPA in this table refers to U.S. EPA procedures using gas chromatography/mass spectrometry (GC/MS).
Source: Means et al., 1993a, Table 2-3.

Table 2-16. Summary of Average Butyltin Analyses

Sample	Butyltin Chloride Concentrations (mg/kg)		
	Mono-	Di-	Tri-
Untreated grit[a]	22.4	15.0	70.7

(a) GC (gas chromatography) analysis.

Table 2-17. Chemical Data on Debris Samples from Hunters Point Annex

Sample ID/Type	TTLC[a] (mg/kg)		STLC[b] (mg/L)	
	Cu	Pb	Cu	Pb
DEB-1/wood	1,100	270	83	6.7
DEB-2/wood	150	53	74	9.5
DEB-3/wood	790	170	14	2.3
DEB-4/cloth	2,900	730	42	20
DEB-5/cloth	940	560	170	20
DEB-6/cloth	4,700	970	200	74
DEB-7/metal	1,300	93	1.6	6.7
DEB-8/metal	460	1,100	0.12	2.5
DEB-9/metal	1,100	470	0.13	1.1

(a) TTLC limits for copper and lead are 2,500 mg/kg and 1,000 mg/kg, respectively.
(b) STLC limits for copper and lead are 25 mg/L and 5 mg/L, respectively.

Table 2-18. TCLP Pb Data on Cloth Debris

Sample #	TCLP Pb (mg/L)
Cloth-1	0.9
Cloth-2	6.3
Cloth-3	4.1
Avg. ± stan. dev.	3.8 ± 2.7

Table 2-19. TTLC and STLC Pb and Cu and TCLP Pb Data on Wood Debris

	TTLC (mg/kg)		STLC (mg/L)		TCLP (mg/L)
Sample #	Cu	Pb	Cu	Pb	Pb
Wood-1	860	270	33	7.4	<0.5
Wood-2	2,700	620	190	12	<0.5
Wood-3	2,000	310	90	8.5	<0.5
Wood-4	1,800	150	61	4.4	<0.5
Avg. ± stan. dev.	1,840 ± 760	340 ± 200	94 ± 68	8.1 ± 3.1	<0.5

pile were analyzed for total and WET-soluble Pb and Cu and TCLP Pb. The results are presented in Table 2-19.

Debris analysis results indicate that the debris are hazardous waste. When debris are separated from the untreated grit in preparation for grit recycling, the resulting debris will need to be managed as hazardous waste.

2.4 Asbestos Analyses

Two grab samples of untreated grit collected at random from the large grit pile were analyzed for asbestos using optical microscopy. Asbestos was not detected in either sample.

2.5 Matrix Properties

Samples of untreated and sulfide-treated grit were characterized using standard sieve grain-size analyses. The results are shown in Table 2-20. The correspondences of the measured size

Table 2-20. Hunters Point Grit Sieve-Size Analysis

Sulfide-Treated Grit				Untreated Grit			
Sieve Size	Weight (grams)	Cum%	Ind%	Sieve Size	Weight (grams)	Cum%	Ind%
−2.5	25.1	2.04	2.04	−2.5	37.8	2.98	2.98
−1.0	39.0	5.22	3.18	−1.0	53.5	7.20	4.22
0	264.5	26.77	21.55	0	477.2	44.86	37.66
+1	502.3	67.62	40.85	+1	552.2	88.44	43.58
+2	304.6	92.52	24.9	+2	117.0	97.67	9.23
+3	73.2	98.24	5.72	+3	23.0	99.49	1.83
+3+	18.6	100.00	1.76	+3+	6.4	100.00	0.51

ranges to standard sieve size, actual mesh opening, and Wentworth soil size class are shown in Table 2-21. Both the untreated and sulfide-treated grits are classified as coarse sand. The sulfide-treated grit has a higher proportion of fines due to the addition of fly ash during the chemical stabilization demonstration. Both grits are classified as coarse sand (see Table 2-21).

2.6 Radioactivity Monitoring

Monitoring for radioactivity was performed at both the untreated and treated grit piles. After each pile was uncovered and material was removed and loaded into material bins for the field demonstration, the exposed area of each pile was monitored for radioactivity. An Eberline E-120 Geiger counter was used to detect gamma radiation, and an Eberline PAC-463 meter was used to detect any alpha or beta radiation. No activity was noted above background levels in the areas that were monitored.

Table 2-21. Particles Sizes Corresponding to Sieve Mesh #

	U.S. Standard Sieve Mesh #	Millimeters	Phi ϕ	Wentworth Size Class
Gravel	Use wire square	4,096	−12	Boulder (−8 to −12ϕ)
		1,024	−10	
		256	−8	
		64	−6	Cobble (−6 to −8ϕ)
		16	−4	Pebble (−2 to −6ϕ)
	5	4	−2	
	6	3.35	−1.75	Granule
	7	2.80	−1.5	
	8	2.36	−1.25	
	10	2.00	−1.0	
Sand	12	1.7	−0.75	Very coarse sand
	14	1.4	−0.5	
	16	1.18	−0.25	
	18	1.00	0.0	
	20	0.85	0.25	Coarse sand
	25	0.71	0.5	
	30	0.60	0.75	
	35	0.50	1.0	

Table 2-21. Particles Sizes Corresponding to Sieve Mesh # (continued)

	U.S. Standard Sieve Mesh #	Millimeters	Phi ϕ	Wentworth Size Class
Sand (cont'd)	40	0.425	1.25	Medium sand
	45	0.355	1.5	
	50	0.300	1.75	
	60	0.250	2.0	
	70	0.212	2.25	Fine sand
	80	0.180	2.5	
	100	0.150	2.75	
	120	0.125	3.0	
	140	0.106	3.25	
	170	0.090	3.5	Very fine sand
	200	0.075	3.75	
	230	0.063	4.0	
	270	0.053	4.25	
Mud	325	0.045	4.5	Coarse silt
	Analyzed by Pipette or Hydrometer	0.038	4.75	
		0.032	5.1	
		0.0156	6.0	Medium silt
		0.0078	7.0	Fine silt
		0.0039	8.0	Very fine silt
		0.0020	9.0	Clay
		0.00098	10.0	
		0.00049	11.0	
		0.00024	12.0	
		0.00012	13.0	
		0.00006	14.0	

3.0 REGULATORY COMPLIANCE

On August 18, 1995, the California Department of Toxic Substances Control (DTSC) Resource Recovery Section issued a management memo for "Use Constituting Disposal" (Appendix C). The purpose of this management memo is to encourage the recycling of suitable waste materials into construction materials and to establish conditions to assure that the recycling occurs safely and can be monitored as necessary to prevent abuses. The memo ratifies an earlier draft policy issued on September 26, 1990. The management memo applies to any recyclable material that is placed on the land or used to produce a product that is placed on the land. Using spent sandblasting grit as asphalt aggregate clearly fits within the scope of the management memo. A California hazardous material reused in a manner constituting disposal is regulated under the California Health and Safety Code (HSC), Section 25143.2(e)(2) unless certain conditions are met. Several of these conditions, which are described more fully in Appendix C, are as follows:

1. Policy only applies to non-RCRA (California-only) hazardous wastes.

2. Hazardous constituents with a concentration greater than or equal to the regulatory STLC shall have chemically reacted or become physically bound so as not to leach from the product in concentrations above the applicable STLC, once the effect or dilution by other ingredients is taken into account.

3. Recyclable composites should add no significant hazard to public health or the environment, either in the recycling process or in the final product.

4. The recyclable composites must met Caltrans specifications or equivalent for proposed use and must be made for commercial use.

A memo from the DTSC indicating that reuse of spent sandblasting grit from HPA meets conditions to be exempt from classification as a waste under HSC Section 25143.2(d)(5) is included as Appendix D. This memo also includes excerpts from California's Hazardous Waste Recycling Laws.

Safely meeting the conditions to exempt grit recycling from regulation as a California hazardous waste is one major goal in allowing responsible and cost-effective management of the grit. As a part of meeting those conditions, protection of worker safety and health and the protection of air, surface water, and groundwater also must be considered. These other environmental protection aspects include obtaining review, concurrence, and/or permits from a wide range of regulatory agencies as well as published public announcements to invite stakeholder input. Project efforts included numerous communications with regulatory agencies such as the Glenn County Department of Health, the Glenn County Air Pollution Control District, the Regional Water Quality Control Board, the California Air Resources Board, and the DTSC. The overall regulatory interactions for the project are summarized in Figure 3-1. These interactions include a number of phone calls and distribution of project documentation, such as the project work plan and data report. Also, letters were written to the following: Greg Lindholm of the Glenn County Department of Health, to clarify the project; Jessie Schnell of DTSC, to request a letter from her office indicating that this project is in compliance with department policy; and Dave Song of Western Division (WESTDIV), as input for a public announcement.

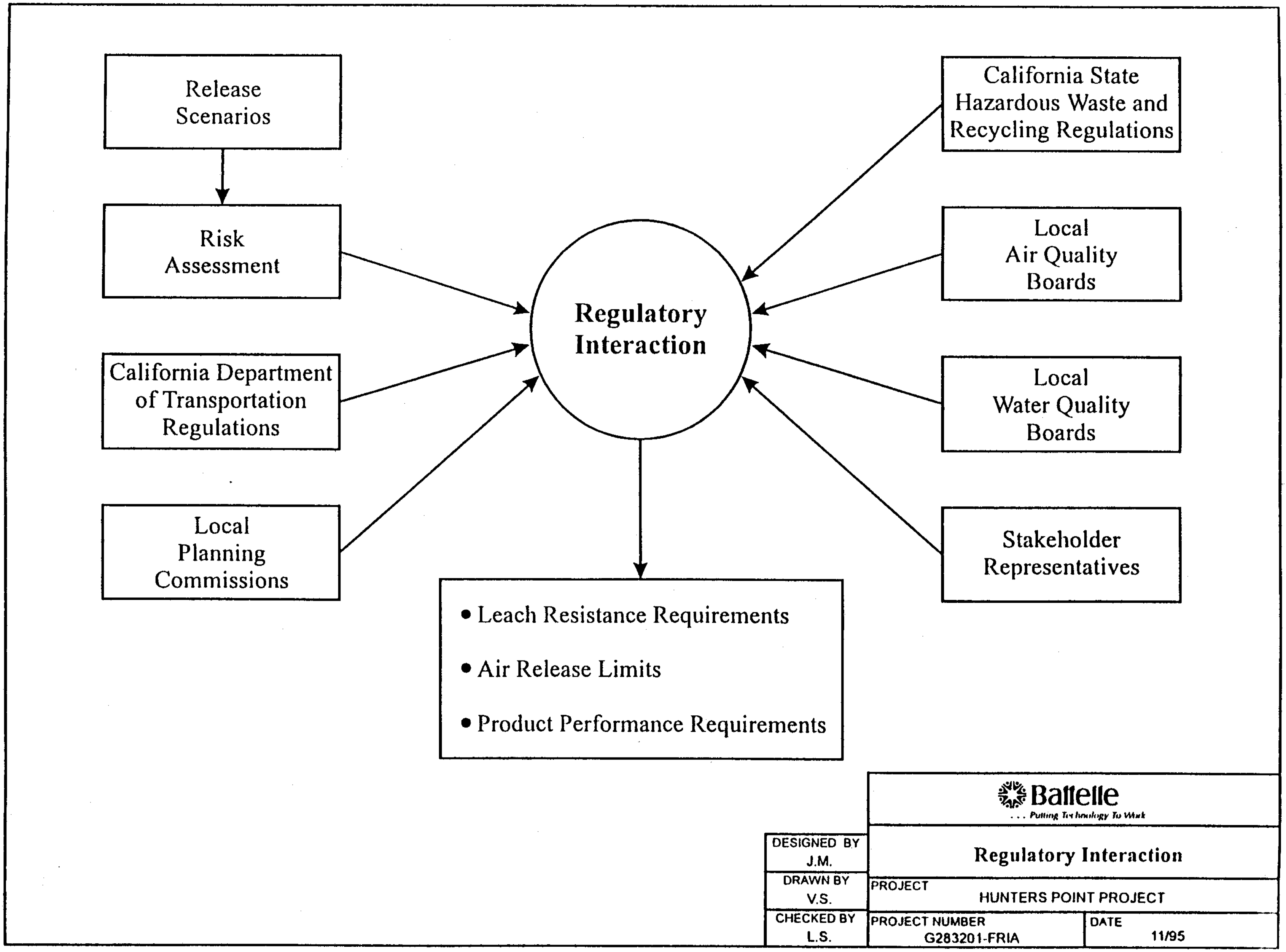


Figure 3-1. Regulatory Interactions for Spent Sandblasting Grit Recycling Project.

Examples of regulatory concurrence documents are provided in Appendices D-1 through D-4. Appendix D-1 shows the concurrence of the California DTSC with the proposed use of spent sandblasting grit from HPA as qualifying for a recycling exclusion. In addition to the DTSC concurrence for the recycling exclusion, local Air and Water Boards also reviewed and concurred with the field demonstration project (see Sections 7.0 and 8.0). The Bay Area Air Quality Management District (BAAQMD) reviewed the planned operations for screening and crushing the spent sandblasting grit at HPA and determined that a permit was not required because the operation was occurring at a federal facility under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), but that the technical requirements of BAAQMD regulations should be followed (Appendix D-2). The Central Valley Region of the California Regional Water Quality Control Board did not require permit application due to the determination by the DTSC that the recycling activity qualified for an exclusion (Appendix D-3). The Glenn County Air Pollution Control Division (GCAPCD) required performance of a risk screening analysis. The California Air Resources Board (CARB) performed the modeling (Appendix D-4) and determined that the worst-case lead concentration was well below regulatory standards and was not expected to cause any adverse human health effects.

The Glenn County Planning Department provided a Conditional Use Permit based on the Orland asphalt plans (Appendix E-1) for using spent sandblasting grit from HPA in the field demonstration. The original Conditional Use Permit and two extensions are provided as Appendices E-2 through E-4.

As described in Sections 4 through 8, the sequence of bench-scale treatability testing, pilot-scale testing, and full-scale field demonstration was organized and conducted to regulatory, scientific, and economic bases to demonstrate the acceptability of reusing spent sandblasting grit as asphalt aggregate. The testing program was designed to show that grit reuse could be done while protecting human health and the environment, meeting regulatory requirements, producing good quality asphalt, and providing an economically viable way to recycle rather a material that would otherwise be a waste.

4.0 TREATABILITY TESTING

This section gives an overview of testing performed in previous projects to develop an effective asphalt formulation for recycling spent sandblasting grit. The treatability study was designed in late 1990 and conducted in early 1991 (Means, 1990).

4.1 Treatability Study Sample Preparations

Bench-scale treatability tests were performed to evaluate the leaching resistance and project quality of the asphalt produced with HPA grit as an additive and to determine an acceptable mix of ingredients (bitumen, aggregate, and grit) for the asphalt. Test samples were produced at Reed and Graham Asphalt of San Jose, California. Physical and chemical tests were run on the asphalt-treated grit test samples at California-certified laboratories. Samples of both the untreated and sulfide-treated grits were evaluated.

The aggregate grading requirements for the coarse aggregate, fine aggregate, and spent sandblasting grit conformed to the California Department of Transportation (Caltrans) Section 39 (see Appendix F) and any pertinent local requirements. The aggregate grading used was 0.5-inch maximum, medium type B (see Caltrans Section 39). Asphalt-treated grit mixtures containing 46% and 7% of untreated and sulfide-treated sandblasting grit were tested in the bench-scale tests. Sandblasting grit of a size less than No. 8 mesh was used in the test. For simplicity, the asphalt-treated grit mixtures will be referred to as 46% mix (untreated and sulfide-treated) and 7% mix (untreated and sulfide-treated).

The asphalt-treated grit mixtures were prepared at 350°F. The asphalt mixtures at this temperature had a viscosity of 170 $\pm$ 20 centistokes (ASTM D1559, 1989). The mass of the asphalt required is about 4.5 to 6.5% of the total weight of the asphalt-treated grit mixture. For the 46% mix, the mass of asphalt used was 5.5% of the total weight of the mixture. Three different asphalt contents (5.3, 5.8, and 6.3%) were used for the 7% mix. About 1.5 kg of each asphalt-treated grit mixture was prepared for the physical properties and chemical leaching tests.

4.2 Treatability Study Testing Methods

4.2.1 Chemical Test Methods

Three chemical leaching tests were conducted on the asphalt samples containing recycled grit. The chemical tests were the CAL WET, to determine whether the cured asphalt-treated grit mixtures met the California Soluble Threshold Limit Concentration (STLC) criterion for heavy metals; the TTLC test, to verify that the cured asphalt-treated grit mixture adhered to the TTLC criterion; and the TCLP, to ensure that the RCRA leachable toxicity criterion was not exceeded.

4.2.2 Product Quality Test Methods

The Hveem Method (ASTM D1560) was the physical property test suite used to establish product quality for the asphalt treatability test samples. Data collected from the Hveem Method include (1) bitumen or asphalt content, (2) stabilimeter value, (3) cohesiometer value, (4) test temperature, (5) density of asphalt-treated grit mixture, and (6) air voids ratio.

The Hveem Method currently is adopted by Caltrans and involves two principal tests. The first test, the stabilimeter test, is a type of triaxial test that determines the resistance to deformation of compacted asphalt mixtures by measuring the lateral pressure developed when applying a vertical load using the Hveem stabilimeter. The second test, the cohesiometer test, determines the cohesion of the compacted asphalt mixtures by measuring the force required to break or bend the sample as a cantilever beam using the Hveem cohesiometer. Other information obtained from the cohesiometer test are the density and air void properties of the asphalt-treated grit mixture.

The centrifuge kerosene equivalent (CKE) test (ASTM D5148) was conducted on the 7% mix. The purpose of this test is to estimate the optimum asphalt content of the asphalt-treated grit mixture. Results of this test were then used to conduct the stabilimeter and cohesiometer tests at the estimated optimum asphalt content, and at greater and lesser asphalt contents, in order to establish and verify the optimum asphalt content. The CKE test consists of saturating with kerosene aggregates of the mixture that pass the No. 4 sieve (considered as the fine aggregate fraction) and then centrifuging at 400 g. The ⅜-inch to No. 4 size aggregate, considered to be the coarse fraction, is saturated with lubricating oil (SAE No. 10 oil or Shell Tellus No. 100 oil) and allowed to drain for 15 minutes at 140°F. Various K factors, K_c (for coarse fraction) and K_f (for fine fraction), are determined from the weight of kerosene and oil retained in the aggregates. From the K factors, the approximate bitumen ratio (ABR) or the optimum asphalt content is read from several plots found in the ASTM standard.

4.3 Treatability Study Test Results

The treatability testing provided information about the leach resistance and physical properties of the product asphalt.

4.3.1 Chemical Test Results

The results of the chemical leach tests for the 46% and 7% mixes are presented in Tables 4-1 and 4-2, respectively. As expected, the TTLC Pb and Cu levels for both mixes were reduced in proportion to the dilution of the grit with aggregate and asphalt. In the case of the 46% mix, the STLC for Pb was below regulatory levels; however, the STLC Cu concentration was about 1.5 times higher than the regulatory level of 25 mg/L. STLC Pb and Cu levels for the 7% mix were below the regulatory limits.

In contrast to the TTLC Pb and Cu levels, the STLC Pb and Cu levels for the mixes were reduced in greater proportion to the dilution of the grit with aggregate and asphalt. Reduction of leachable metal levels indicates that Pb and Cu in the grit were immobilized to a certain extent by the asphalt treatment. The TCLP levels for Pb and Cr for treated and untreated grit were less than the regulatory levels even before the brit was recycled into the asphalt-treated grit mixture. The TCLP levels for Pb and Cr therefore would meet regulatory limits after the grit is recycled into asphaltic concrete.

Table 4-1. Treatability Test Leaching Results (46% Mix)

	TTLC (mg/kg)		STLC (mg/L)		TCLP (mg/L)	
	Pb	Cu	Pb	Cu	Pb	Cr (Total)
Untreated Grit						
Before recycling into asphalt	316	2,180	12.8	140	1.5	0.22
After recycling into asphalt	174	974	0.44	38.5	0.18	0.011
Treated Grit						
Before recycling into asphalt	147	1,230	13.2	78.2	1.7	0.21
After recycling into asphalt	118	985	0.58	44.5	0.43	0.041

TTLC limits (mg/kg): Pb = 1,000; Cu = 2,500.
STLC limits (mg/L): Pb = 5; Cu = 25.
TCLP limits (mg/L): Pb = 5; Cr = 5.
Source: Means et al., 1995.

4.3.2 Product Quality Test Results

The results for the product quality tests for asphaltic concrete samples containing 46% and 7% recycled grit are shown in Table 4-3. Tests were done with both untreated spent grit and sulfide-treated grit.

Stabilimeter test results for the 46% mix (untreated) were below the acceptable Caltrans test limit criteria, but the cohesiometer value exceeded the test limit criteria. The percent voids value also

Table 4-2. Treatability Test Leaching Results (7% Mix)

	TTLC (mg/kg)		STLC (mg/L)		TCLP (mg/L)	
	Pb	Cu	Pb	Cu	Pb	Cr (Total)
Hunters Point Untreated Grit						
Before Recycling into Asphalt	316	2,180	12.8	140	1.5	0.22
After Recycling into Asphalt						
Uncrushed Pellet	18	118	0.076	2.8		
Crushed Pellet	31	179	<0.05	4.4		
Hunters Point Treated Grit						
Before Recycling into Asphalt	118	1,230	13.2	78.2	1.7	0.21
After Recycling into Asphalt						
Uncrushed Pellet	21	109	0.18	3.9		
Crushed Pellet	19	132	0.084	5.8		

TTLC limits (mg/kg); Pb = 1,000; Cu = 2,500.
STLC limits (mg/L); Pb = 5; Cu = 25.
TCLP limits (mg/L); Pb = 5; Cr = 5.
Source: Means et al., 1995.

Table 4-3. Treatability Test Product Quality Results (Hveem Test) for 48% and 7% Mixes

Sandblasting Grit Content	46%		7%						Acceptance Criteria (Medium Traffic)
Quality Test Parameter	Untreated	Sulfide-Treated	Untreated			Sulfide-Treated			
Asphalt Content (%)	5.5	5.5	5.3	5.8	6.3	5.3	5.8	6.3	
Stabilimeter	31	46	42	38	31	36	34	29	35 (min)[(a)]
Cohesiometer	379	374	369	—	—	372	—	—	50 (min)[(b)]
Percent Voids	3.3	7.6	—	—	—	—	—	—	4 (min) to 8 (max)[(c)]

(a) Caltrans criteria for medium-traffic applications.
(b) Asphalt Institute (1962) criterion.
(c) Asphalt Institute (1962) criterion; minimum value for Hveem Test, maximum value as listed for Marshall Test. Note that there is no maximum percent voids value for the Hveem Test in the Asphalt Institute (1962) criterion.
Source: Means et al., 1995.

was below the minimum test limit criteria. However, samples from the 46% mix (sulfide-treated) met the acceptable test limit criteria for the Hveem test.

A decrease in the stabilimeter value was observed for the 7% mix (untreated and sulfide-treated) when the asphalt content was increased from 5.3 to 6.3%. The Caltrans test limit criterion was satisfied by the untreated grit with asphalt contents of 5.3 and 5.8%, whereas for the sulfide-treated grit an asphalt content of 5.3% or less is required. Both types of grit (untreated and sulfide-treated) for this asphalt-treated grit mixture met the cohesiometer test limit criterion. The percent voids test for the 7% mix was not conducted.

The K factors from the CKE test are presented in Table 4-4. Both untreated and sulfide-treated grit for the 7% mix meet the Caltrans criteria for K_c and K_f. The computed ABR or optimum

Table 4-4. Centrifuge Kerosene Equivalent Test for 7% Mix

	Untreated	Sulfide-Treated	Acceptance Criteria (Medium Traffic)
K_c factor	1.4	1.4	1.7 (max)[(a)]
K_f factor	1.1	1.3	1.7 (max)[(a)]
Surface area of aggregate (ft^2/lb)	34.2	29.5	—
Approximate bitumen ratio (ABR)	4.8%	4.8%	—
ABR (corrected for AR 4000 asphalt)	5.8%	5.8%	—

(a) Caltrans criteria.
Source: Means et al., 1993a.

asphalt content after correcting for the asphalt type (AR 4000) was 5.8% for both untreated and sulfide-treated grit. This percent of asphalt content is within the range of the asphalt content used for the Hveem test that met the Caltrans test limits.

4.4 Fate of Butyltin Compounds During Asphalt Process

Butyltin compounds are present as paint chip components in the spent sandblasting grit. The fate of butyltin compounds during heating to make asphaltic concrete and the leach resistance of butyltin compounds in the asphalt to leaching were studied.

A number of grit samples have been analyzed for butyltin compounds, including untreated grit, untreated and sulfide-treated grit heated to 325°F, and TCLP extracts of the untreated and sulfide-treated grit heated to 325°F. The analytical results are summarized in Table 4-5.

The HPA grit contains low levels of butyltin compounds, including monobutyltin (MBT), dibutyltin (DBT), and tributyltin (TBT). Heating to 325°F, such as occurs during asphalt production, did not appear to degrade or volatilize the DBT compound. There is some evidence of removal of the MBT and TBT compounds. The TCLP extracts of the heated grit also show the presence of butyltin compounds.

Table 4-5. Summary of Average Butyltin Analyses

	Butyltin Chloride Concentrations (mg/kg)		
Sample/Treatment	**Mono-**	**Di-**	**Tri-**
Untreated grit[(a)]	22.4	15.0	70.7
Grit heated to 325°F[(b)]			
Untreated	7.8	31.6	13.9
Sulfide-treated	8.2	12.9	15.0
TCLP extracts of heated grits[(a)]			
Untreated	0.23	1.18	0.18
Sulfide-treated	0.23	0.82	0.64
Blanks for above 3 sets of analyses	0.23	0.01	0.003
TCLP extract of untreated grit made into asphaltic concrete[(c)]	ND	0.000096	0.000100
TCLP extract of sulfide-treated grit made into asphaltic concrete	0.000464	0.000066	0.000100

(a) Gas chromatography (GC) analysis.
(b) Gas chromatography/mass spectrometry (GC/MS) analysis.
(c) Hydride generation analysis.
ND = not detected.
Source: Means et al., 1993a, Table 1-4.

The final test involved the analysis of TCLP extracts from untreated and sulfide-treated grit made into asphalt test specimens. The results are shown in the last two lines of Table 4-5. The butyltin levels in these TCLP extracts are extremely low, in the nanogram per liter (part per trillion) range. Therefore, it appears that the butyltin compounds are being destroyed or transformed to a nonreleasable form when the spent sandblasting grit is processed with heated bitumen to form asphalt.

4.5 Regulatory Significance of Treatability Results

The results of the treatability tests indicate that recycling of spent sandblasting grit as aggregate in asphaltic concrete is a potentially effective and implementable management option. Both chemical leaching resistance and physical performance parameters were satisfactory for the 7% grit mixture.

The California Department of Toxic Substances Control (DTSC) regulatory chemical leach test requirements (CCR, Title 22, Chapter 11, Section 66261.24) also can be satisfied through dilution by selecting the appropriate asphalt/aggregate/grit mix. The 7% grit mix passes the chemical criteria limits by a margin that allows for some heterogeneity in the composition of the asphalt-treated grit. Physical tests have shown that the Caltrans or Asphalt Institute performance criteria can be met by selecting the appropriate asphalt/aggregate/grit mixtures and by varying the asphalt content in the mixture.

5.0 PILOT-SCALE ASPHALT MIXING AND PLACEMENT

This section gives an overview of testing performed in previous projects to demonstrate the feasibility of recycling spent sandblasting grit and prepare small test sections to allow testing of the long-term effectiveness of the asphalt formulation.

As discussed in the following sections, three asphaltic concrete test strips were laid on an existing stretch of road at HPA along Spear Avenue between Morell and Cochrane Streets in November 1991. The long-term stability of these test strips was studied for several years (see Section 6.0) to accumulate data on the leaching resistance and physical integrity of asphaltic concrete containing about 5% spent sandblasting grit as part of the aggregate.

5.1 Background Characterization at Pilot-Scale Test Strip Site

The area where the test strips were laid was analyzed for background metals content to determine baseline metals concentration. Elevated levels of metallic contaminants might interfere with the long-term stability analyses done periodically to measure changes in the metal leaching resistance or content of the asphaltic concrete.

Three background soil samples were collected from the surface adjacent to the edge of each planned test strip, resulting in nine samples total. The nine samples were collected in the area of the roadgrinding test strips along Spear Avenue between Horne Avenue and Cochrane Street. Three additional samples were collected from on the hillside just parallel to the three long-term test strips located on Fisher Avenue. Sampling locations are shown in Figure 5-1. Samples were collected using a stainless steel scoop and tested for TTLC Pb and Cu, STLC Pb and Cu, and TCLP Pb and Cr by a California-certified analytical testing laboratory.

Based on the results in Table 5-1, it is apparent that several of the samples from the vicinity of Spear Avenue and all three of the samples from the hillside adjacent to Fisher Avenue contain elevated levels of Cu and/or Pb, the principal metals in the asphalt-treated sandblasting grit. Therefore, in future sampling of the asphalt test strips for purposes of chemical analyses, asphalt cores will be washed thoroughly prior to analysis to remove any contaminated dirt.

5.2 Hydrogen Sulfide Monitoring

The sulfide-treated pile was monitored in the field for hydrogen sulfide (H_2S). The grit in this pile had been treated with small amounts of sodium hydrosulfide during the stabilization/solidification demonstration of December 1989. During the excavation of the treated pile, a Gastech GX-91 H_2S monitor was used to ensure that H_2S concentrations did not pose a safety hazard to the sampling team.

Levels detected at the bottom of the treated pile with the monitor probe just one inch above material ranged from 2 to 7 ppm, but dissipated quickly. The maximum level of H_2S detected was 0.5 ppm in the area of the personnel doing work near the excavation, compared to an action level of 5.0 ppm.

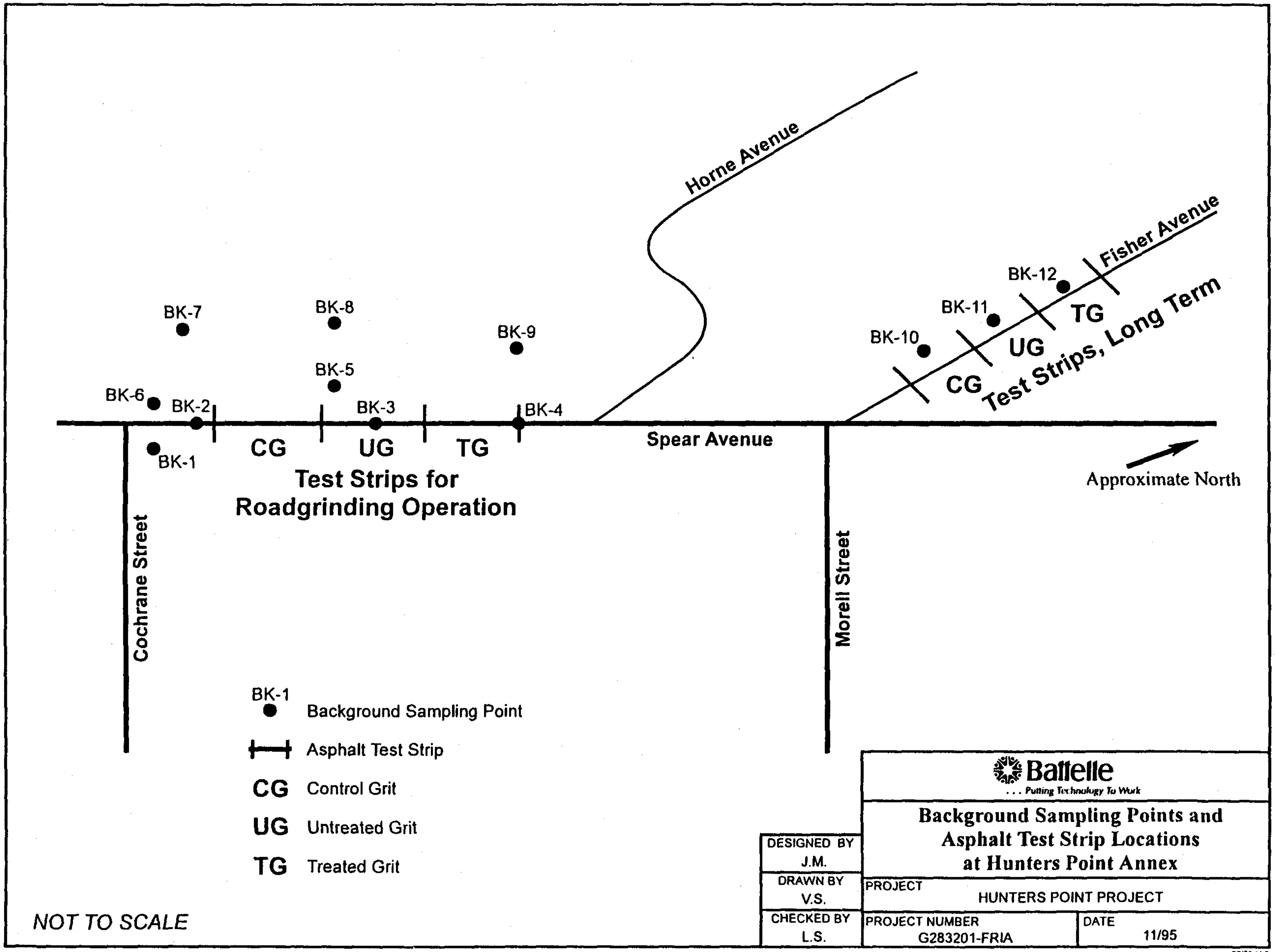


Figure 5-1. Background Sampling Points and Asphalt Test Strip Locations at Hunters Point Annex.

Table 5-1. Chemical Data on Threshold Soils at Hunters Point Annex

Sample ID	Total (mg/kg)			WET-soluble (mg/L)		TCLP (mg/L)	
	Cu	Pb	Cr	Cu	Pb	Cu	Pb
BK-1	350	510	—	7.5	1.9	0.51	1.4
BK-2	*	*	—	0.22	0.71	0.08	0.6
BK-3	20	30	—	0.24	1.4	0.03	0.1
BK-4	190	490	—	6.5	17	0.12	0.2
BK-5	1,800	560	—	110	22	19	1.4
BK-6	65	80	—	1.6	1.8	0.03	0.1
BK-7	47	67	—	1.4	2.3	0.02	0.1
BK-8	53	50	—	1.3	1.8	0.01	0.1
BK-9	53	60	—	1.2	1.4	0.01	0.1
BK-10	110	320	68	—	—	—	—
BK-11	94	2,500	79	—	—	—	—
BK-12	82	250	71	—	—	—	—

* Insufficient sample available for analysis.

5.3 Permits and Variances

This pilot-scale field demonstration was conducted under a research and development (R&D) variance from California EPA, DTSC. A copy of that variance is provided in Appendix G. Also, the Bay Area Air Quality Management District (BAAQMD) issued an Experimental Exemption to cover field demonstration activities at the Reed and Graham, Inc. asphalt plant in San Jose. A copy of this exemption is provided in Appendix H.

5.4 Grit Excavation at HPA and Transport to the Asphalt Plant

The loading and transport of grit from HPA to Reed and Graham in San Jose took place on Wednesday, November 20, 1991 and involved several different parties. An equipment company was contracted to provide a water truck and operator to wet down the work area and minimize dust emissions during grit excavation and the movement of heavy equipment at HPA.

The grit was loaded nearly to capacity into four 2.5-yd^3-capacity material bins with closeable lids, two each for the untreated and treated grit. Pacific Environmental, Inc. provided the bins and the trucks and operators to transport the grit to the Reed and Graham asphalt plant. Battelle supplied the truck driver with a driver's packet which included an enlarged map of the route to the plant. The packet also included material safety data sheets for Cu and Pb powder and the results of chemical analyses performed on the sandblasting grit. Battelle staff also discussed any potential hazards associated with the grit and answered questions for the driver. The truck transporting the material bins was a completely enclosed type with a rear door and hydraulic lift gate. Material bins were filled on the lift gate and then pushed into the truck and secured to the walls. A hazardous materials transportation manifest was not required per the R&D variance from DTSC. The driver was provided with a Bill of Lading stating pickup location, description of cargo, and destination.

American Environmental, Inc. was contracted to excavate the grit because this firm had installed the tarpaulins and would be the best qualified to cut the tarpaulins and then repair them afterwards. A section of tarpaulin approximately 10 feet by 10 feet was removed from each of the two grit piles. Grit material was excavated and loaded into the material bins with a backhoe. The backhoe had an enclosed cab to protect the operator from fugitive dust. However, a filter cassette sampler was placed on the lapel of the backhoe operator's shirt to assess any exposure to inhalable metals. This sampler was run for the duration of the grit excavation and loading operation. The filter was analyzed for total Pb, Cu, and Cr.

After the grit for the field demonstration had been satisfactorily loaded into the bins and the sampling and monitoring described in Section 5.1 and 5.2 were completed, the tarpaulins were resecured over the grit piles and the seams were heat-sealed to prevent infiltration of rain. The grit was successfully and uneventfully transported to Reed and Graham in San Jose.

5.5 Grit Storage at the Asphalt Plant

Upon arrival at the asphalt plant, the material bins containing grit were offloaded and placed in a low traffic area in one corner of the yard. Each bin was labeled with hazardous materials signs which identified the contents as Cu- and Pb-contaminated sand. A 3-inch-wide yellow caution ribbon was installed around the bins to isolate them from any usual plant activity in that area. The bins remained at this location until the screening operation took place. Empty bins were reloaded during the screening operation and stored at this same location until the grit was used in the production of asphaltic concrete on Saturday, November 23, 1991.

5.6 Background Air Monitoring at the Asphalt Plant

Several days prior to the screening operation and asphalt production, a background air monitoring test was performed on the premises of the asphalt plant to establish a baseline for fugitive dust emissions and contaminants already present in the ambient air. A portable weather station which indicates wind speed, wind direction, and ambient temperatures was set up to obtain site-specific meteorological conditions.

Three air monitoring and sampling locations were selected, two downwind and one upwind of the screening operation area (Photo 5-1). Each monitoring location was equipped with an optical dust monitoring instrument which reports a time-weighted average of fugitive dust emissions.

One of the downwind monitoring locations was equipped with a filter cassette sampler that collects particulates on the filter, which was chemically analyzed for total Cu, Pb, and Cr. Background air data were collected for approximately 90 minutes. During that time several meteorological data points were also collected regarding wind speed, wind direction, and air temperature. Air monitoring results are recorded in Section 6.1.

5.7 Screening Operation at Asphalt Hot Plant

Prior to the screening operation, a meeting was held with the employees that work at the asphalt hot plant and who would be involved in screening and/or asphalt production to discuss the safety aspects of the project. Battelle staff gave a brief history of the project at HPA and discussed health and safety concerns. A copy of the work plan was made available for employees to review. Several questions about personal safety and protective equipment required for handling were discussed.

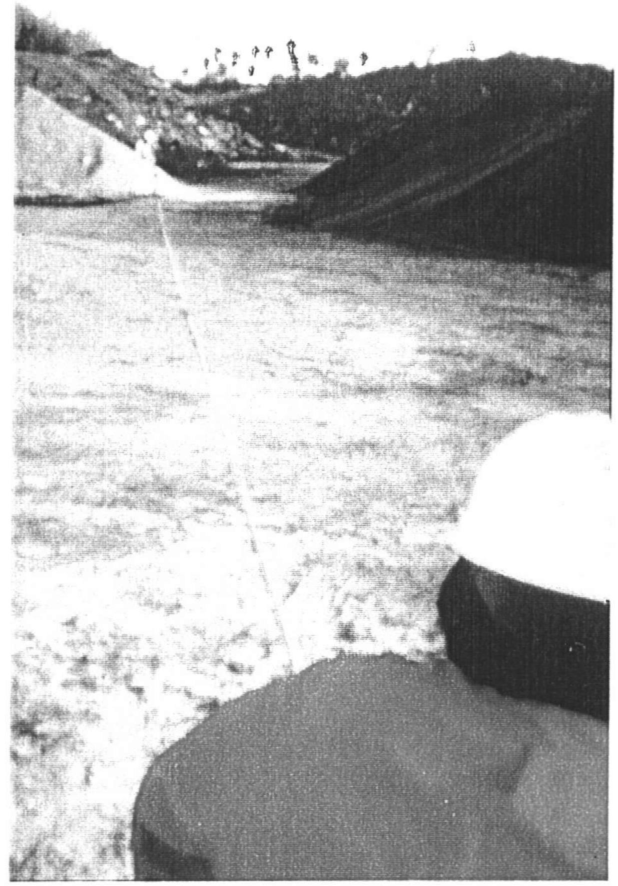


Photo 5-1. Locating air monitoring stations for the pilot-scale screening operation at Reed and Graham Asphalt Co., San Jose, California.

The screening operation was conducted on Friday, November 22, 1991 starting at about 3:00 pm and continuing for approximately 3 hours. Personnel involved in grit handling wore coveralls, hard hats, gloves, and half-face respirators. The screen was a conveyor-type feed with a feed hopper at one end and a ⅜-inch vibrating screen at the other end. A material bin was chained into the bucket of a front-end loader and emptied into the feed hopper. The empty material bin was then taken to the opposite end of the screen and placed under a shoot through which the screened material would pass. The oversized reject material was vibrated off the top of the screen and collected in the bucket of a front-end loader. Polyethylene tarpaulins were placed on the ground under the entire screening area to contain any grit which spilled. When everything was in place, the feed belt was started and the screening process was begun. The reject was rescreened at least two times to ensure that as much grit as possible passed through the screen. The material that didn't pass through the screen was placed into 55-gallon waste drums, and, after California EPA approval, transported back to HPA and stored inside a Navy warehouse.

Air monitoring for particulates was conducted by Battelle during the screening operation (Photo 5-2). Asphalt plant employees wet down the area with water before any activities took place. Battelle set up three air sampling and monitoring stations, one upwind of the screen and two downwind of the screen. Each station was equipped with an optical dust monitoring instrument with a preset audible alarm level of 5 mg/m^3 and particulate filters as well. The three filters were analyzed for total Cu, Pb, and Cr. A portable weather station was used to record site-specific meteorological data. A personal monitoring device was worn by the Reed and Graham employee who worked in the area of maximum fugitive dust emissions.

Winds during the screening process were very slight. Samplers were turned on approximately 15 minutes prior to the start of the screening. Hydrogen sulfide monitoring also was performed while screening the treated grit.

5.8 Asphalt Production at the Asphalt Plant

The field demonstration was conducted on Saturday, November 23, 1991. The asphaltic concrete containing sandblasting grit was produced at the Reed and Graham asphalt plant starting around 8:00 am Saturday morning, ending approximately 12:30 pm (see Photo 5-3). Ms. Jessie Schnell of California EPA, DTSC, observed the activities at the asphalt plant. After each batch was produced, the asphaltic concrete was transported immediately to HPA for paving. The elapsed time between production and paving was critical because the asphaltic concrete needs to be approximately 250°F or hotter for effective paving. The paving operation is described in Section 5.9.

Three different batches of asphaltic concrete test material were produced:

- A control batch, containing only normal graded aggregate and no sandblasting grit,
- Asphaltic concrete containing untreated sandblasting grit from HPA, and
- Asphaltic concrete containing sulfide-treated sandblasting grit from HPA.

The order of the production of the three batches was first control (at about 8:30 am), followed by untreated grit (at about 10:30 am), followed by treated grit (at about noon). The actual batching process required only 10 to 15 minutes per batch.

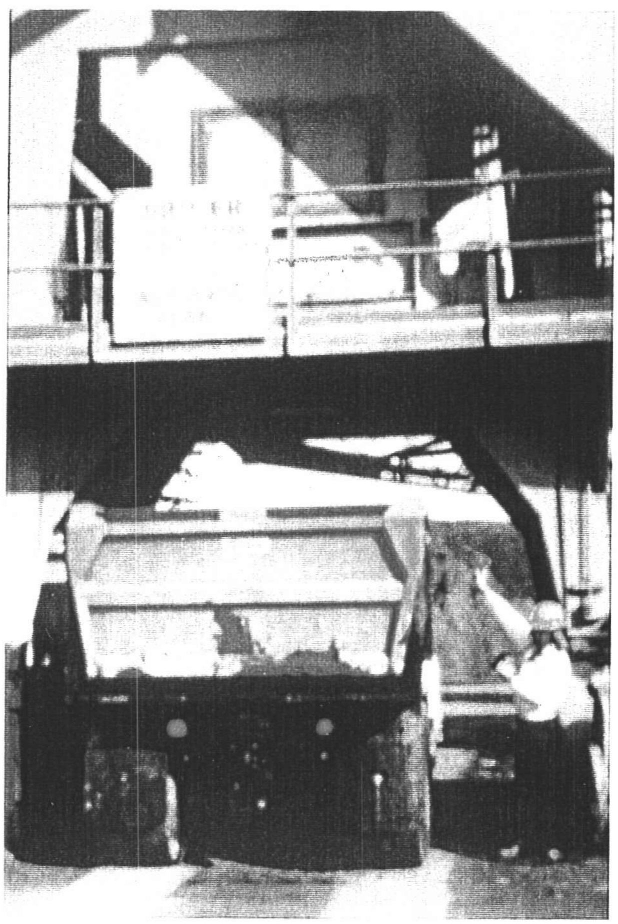


Photo 5-2. Air monitoring for sulfide emissions.

Approximately 30 tons of test asphaltic concrete was prepared per batch, shipped to HPA in two 15-ton-capacity end-dump trucks. After the two trucks were loaded (see Photo 5-4), the load was covered with a tarpaulin prior to transport. The asphalt plant was then emptied of any excess material remaining in the mixer, approximately 10 tons of excess material per batch. The excess material containing sandblasting grit was placed in two piles in an isolated part of the plant yard, and was sampled for chemical analysis of total and WET-soluble metals to determine if the grit could be crushed and recycled back into aggregate in a future paving application. The decision on how to dispose of this excess material was made in consultation with California EPA (see Section 6.5).

Approximately 1.5 tons of sandblasting grit was incorporated into each of the two 30-ton batches of test asphalt, therefore corresponding to an average grit concentration of approximately 5% by weight. The concentration was actually slightly less than 5% because some of the grit was incorporated into the 10 tons of excess asphalt heel in the mixer as noted above. An average grit loading of 7% by weight was the target value; however, it proved difficult to accurately achieve this value during these short production runs,

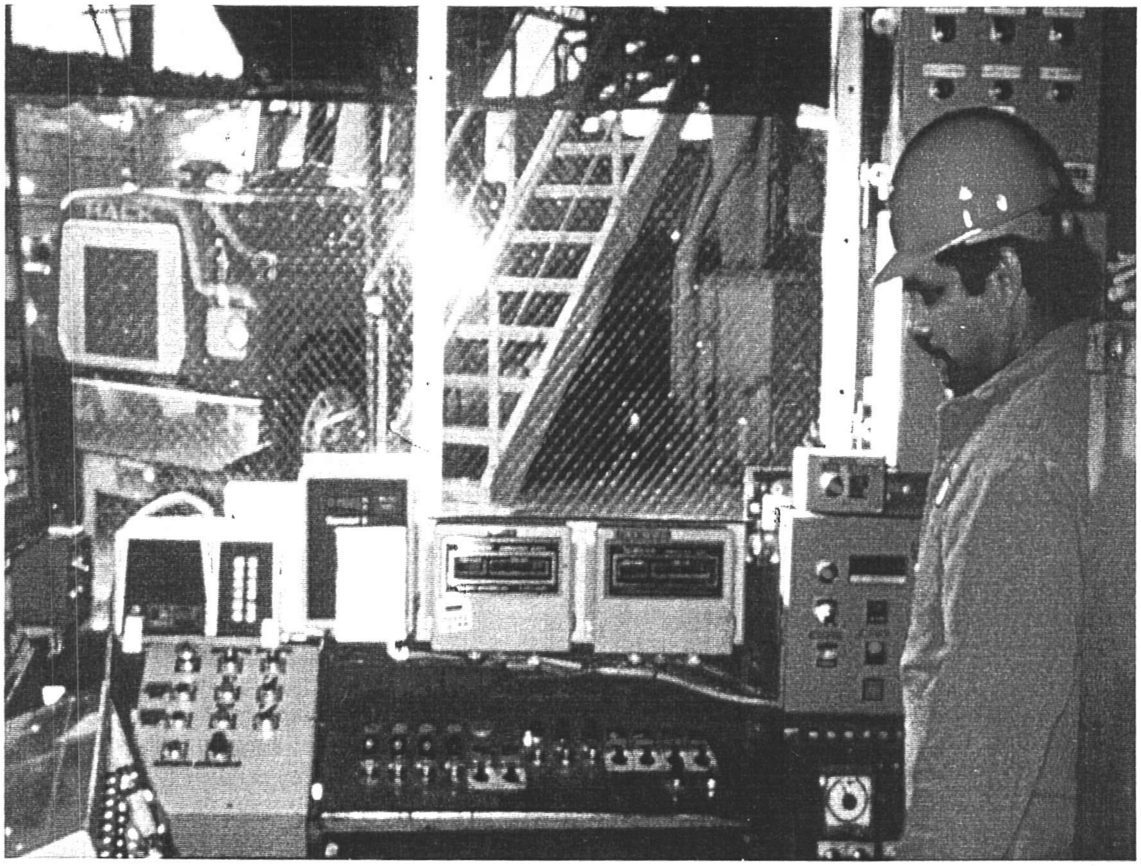


Photo 5-3. Asphalt production at Reed and Graham Asphalt Co., San Jose, California during the pilot-scale demonstration.

because the asphalt plant would normally produce hundreds of tons of asphalt per hour. During a longer production run or during normal full-scale processing, accurate grit metering into the asphaltic concrete would not be difficult to achieve after an initial calibration period.

Other process information is as follows:

- 5.3% target oil or bitumen content,
- Normal 3/8″ - graded aggregate mixture (apart from the added sandblasting grit), and
- The target production temperature of 300°F, somewhat higher than normal to ensure adequate temperatures after the 1½-hour commute to HPA for paving.

Each batch of asphaltic concrete was sampled by collecting approximately 5 gallons of loose asphalt material at the hot plant immediately after production. The loose material was later pressed into test pellets and cores under simulated paving compaction conditions, for chemical and physical properties measurements. Results are reported in Section 6.2.

Also, air monitoring for total fugitive dust using an optical dust monitoring instrument and for hydrogen sulfide was conducted during asphalt production. Hydrogen sulfide was monitored

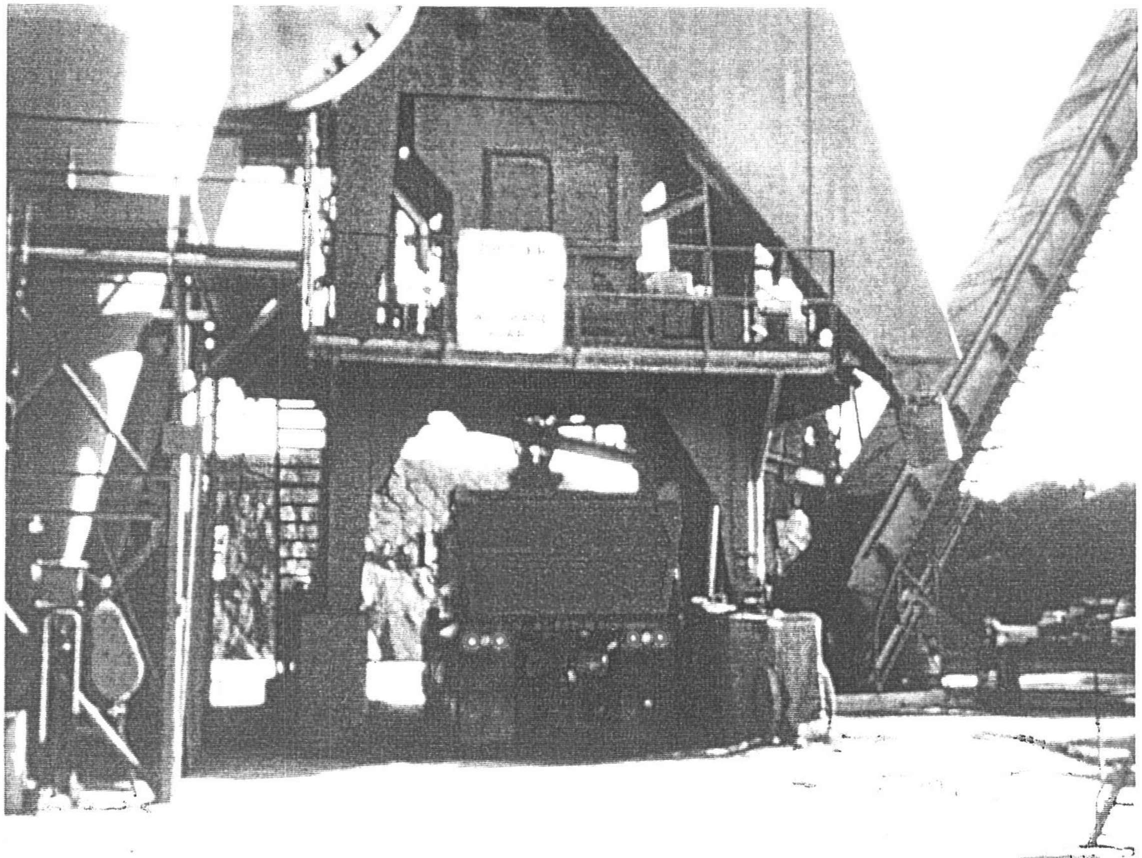


Photo 5-4. Loading hot asphalt into trucks for transport to the site.

continuously at ground level by two different individuals during the processing of the sulfide-treated grit. At no time was there any hydrogen sulfide detected at the hot plant. The results of the fugitive dust monitoring are reported in Section 6.1.

A 30-ton batch of asphaltic concrete will provide sufficient material to pave approximately 2,400 square feet of roadway at an average thickness of 2 inches. Each batch produced for this demonstration was used to pave two different test strips at HPA, one larger strip for long-term monitoring and one smaller strip for a roadgrinding air emissions test (see Section 6.4).

5.9 Roadway Application of the Asphalt Test Strips

5.9.1 Introduction

The asphaltic concrete test material was successfully transported to HPA without incident and was applied to six different test strips at HPA, as follows:

- Two strips containing standard production (control) asphaltic concrete,
- Two strips containing untreated sandblasting grit, and
- Two strips containing sulfide-treated sandblasting grit.

Asphaltic concrete was applied to two different stretches of road at HPA (see Photo 5-5). The field activities and measurements made during placement of the test strips are documented in Appendix I. Three of the six test strips (one each of the asphaltic concrete control, untreated grit, and sulfide-treated grit) were laid for long-term physical and chemical testing. These strips were laid side-by-side extending the width of the road, and measure approximately 30 feet by 50 feet in area by 2 inches deep. Their location is on the south end of Fisher Avenue (Figure 5-1), close to the intersection of Spear Avenue. These test strips were sampled for physical and chemical properties measurements several days after application and will be resampled at approximate intervals of 6 months for the next several years.

The second series of three test strips was laid on Spear Avenue (Figure 5-1), near Building 302, just southwest of the intersection with Fisher Avenue. Each of these strips was laid in series on the northern side of the road and measures approximately 18 feet wide by 50 feet long by 2 to 2.5 inches deep. After approximately 6 months, a roadgrinding operation on these strips is planned to measure the release of fugitive dust and contaminants (see Section 6.4).

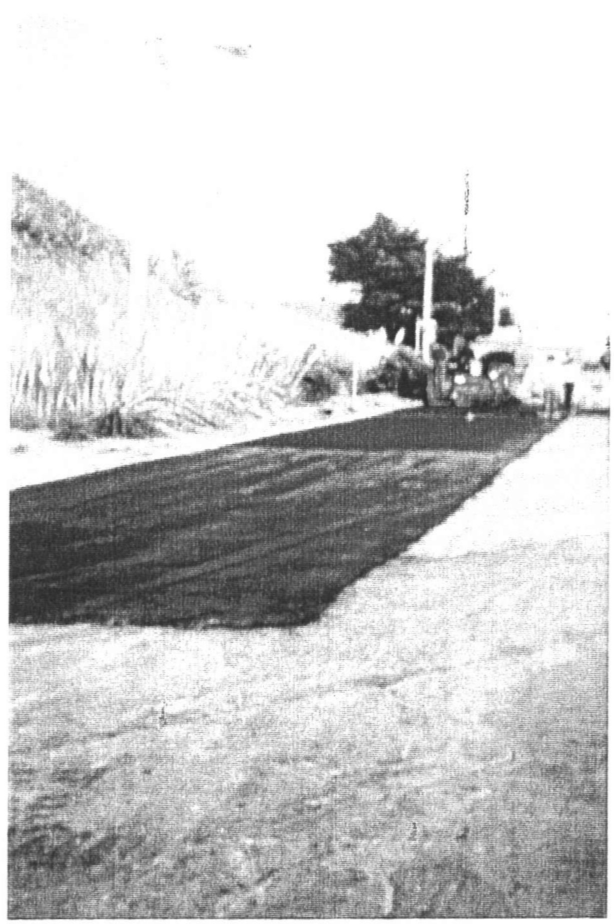


Photo 5-5. Laying the asphalt test strips for the roadgrinding test at Hunters Point Annex.

5.9.2 Surface Preparation

Each test plot was prepared for application in the same manner as normal roads. The crew supervisor inspected each test plot for any failures that might exist and removed vegetation and dirt from the road surface where the test strips were to be installed.

Traffic control barricades were set up to block off the test areas from local traffic, and the fire department and security at HPA were notified. A tack coat was applied to the test areas to ensure a bond between the old pavement and the asphaltic concrete overlay. An SS-1H asphaltic emulsion was applied at a rate of 0.10 gallon per square yard. Subgrade pavement surface temperatures were measured to ensure that the existing pavement was not too cool to pave. The subgrade pavement surface temperatures ranged between 55 and 57°F, which is acceptable.

5.9.3 Asphalt Application

Approximately 40 minutes after the tack coat application, the first two trucks from the asphalt plant arrived at HPA. The trucks contained the standard production (control) asphaltic concrete normally produced by the plant. The field engineer recorded temperatures of the asphaltic concrete at 303°F in the first truck and 315°F in the second truck.

The first truck emptied its load into an automatic screen with a spread of 10 feet in width. The screen then began to apply asphalt to the long-term control pilot-scale test strip. Asphalt temperatures were measured during the initial lay and ranged from 247°F to 260°F. After the asphalt had been applied to the long-term test strip, the screen moved down to the roadgrinding operation test strip while a steel-wheeled roller began to compact the freshly laid asphalt. Breakdown rolling compacted the grit/asphalt to obtain the needed density. Then intermediate rolling was conducted to seal and densify the surface. The finish rolling provided a smooth road surface. Densities were checked using a nuclear densitometer which showed 95% compaction on the long-term control test strip. Once the roller had finished on the long-term strip, the operator moved to the roadgrinding control test strip and repeated the rolling operation there.

The first truck of asphaltic concrete containing untreated grit arrived shortly after noon at HPA. The second truck arrived soon thereafter. The first truck offloaded into the hopper of the automatic spreader, and the temperature of the asphaltic concrete was recorded at 296°F. The spreader began laying the untreated grit asphalt on the long-term test strip at Fisher Avenue and was immediately followed by the roller. After the spreader completed its application of asphaltic concrete to the long-term strip, it immediately moved to the Spear Avenue grinding strip area and began application there. Rolling continued at the long-term test strip. The field engineer followed the roller and recorded temperature data at several points, ranging from 260°F to 270°F, on the long-term test strip. As soon as the roller operator was finished rolling the untreated test strip he moved to the roadgrinding operation strip to roll the material which had just been applied by the spreader. The nuclear densitometer measured percent compaction of 95 to 96% on the long-term test strip.

The asphaltic concrete containing sulfide-treated grit arrived at HPA at 14:10 hours. The temperature of the asphaltic concrete taken from the spreader hopper was recorded at 303°F. Temperatures of the treated grit asphalt after rolling ranged from 260° to 270°F. As soon as the long-term test strip was completed, the roller moved to the roadgrinding area and began rolling the treated test strip. The test strips were inspected by the field engineer for smoothness and uniformity.

After all rolling was completed, fog seal was applied to all the test strips. All asphalt application activities were performed by Reed and Graham, Inc. and their contractors (see Photo 5-6).

5.10 Sampling and Laboratory Analysis of Asphaltic Concrete Test Specimens

In addition to the loose asphaltic concrete samples described in Section 5.8, asphalt core samples were collected from the long-term test strips several days after the asphaltic concrete was applied. Five undisturbed core samples were collected (five cores of each control, untreated, and sulfide-treated) from each long-term test strip in November 1991. A portable drilling machine along with a water-cooled diamond-tipped coring bit was used for core collection (see Photo 5-7). Core samples were collected in June 1993 and June 1994 to allow testing of long-term performance (see Sections 6.2 and 6.3).

The asphaltic concrete test samples were analyzed for the following physical and chemical parameters in order to assess compliance with Caltrans and DTSC sandblasting grit recycling criteria:

- Stabilimeter value
- Cohesiometer value
- Percent voids

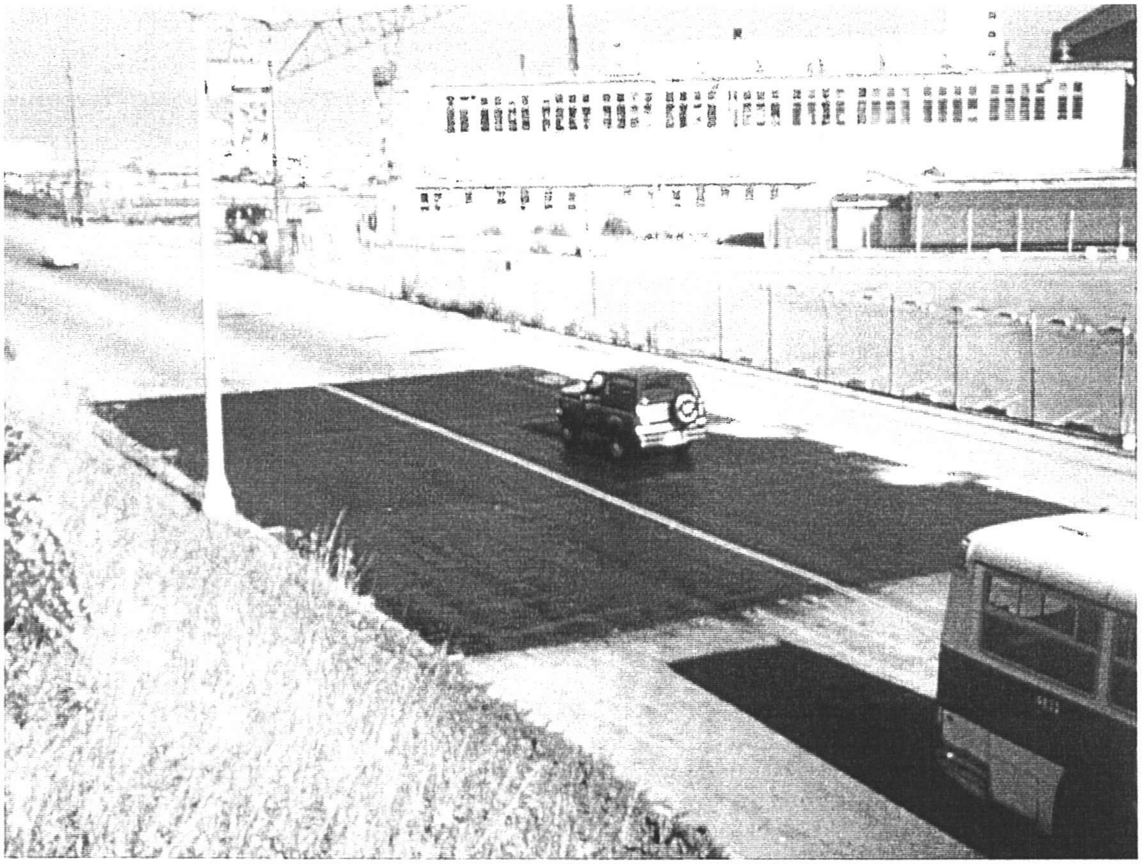


Photo 5-6. Long-term test strip installed at Hunters Point Annex.

- WET-soluble Cu and Pb
- Total Cu and Pb

All analyses were conducted by a California-certified laboratory. Results are discussed in Section 6.0.

Photo 5-7. Coring the long-term test strips to collect samples for chemical and physical testing.

6.0 PERFORMANCE TESTING OF PILOT-SCALE TEST STRIPS

The section discusses the results of (1) the air monitoring activities that were conducted during different phases during the pilot-scale test, (2) the chemical and physical testing analyses conducted on the three different test strips, (3) the regulatory compliance implications of the test results, (4) the methods used and results obtained in the roadgrinding test, and (5) analysis results from the excess asphalt remaining at Reed and Graham. Testing demonstrated that test strips did not degrade in leaching resistance or physical performance as a result of exposure to normal weather and traffic conditions. Compliance with regulatory requirements is discussed in Section 6.3. The roadgrinding test demonstrated that normal road repair activities on recycled grit paving would not generate excessive airborne contaminant levels. The roadgrinding test is described in Section 6.4.

6.1 Air Monitoring Results During Pilot-Scale Asphalt Production

During the pilot-scale field test at the asphalt hot plant from November 19 through November 23, 1991, a series of air monitoring tests were conducted. The tests were designed to assess the potential health impacts of dust generated by various activities associated with the production of the grit-containing asphalt. Tests were included to measure the background levels of windborne dust plus ambient concentrations of Cr, Cu, and Pb. These levels were compared to the concentrations from the process being monitored. Personal samplers were included to assess any potential for worker exposure for equipment operators. A portable meteorological monitoring instrument was used to collect site-specific wind speed and direction during the tests.

A summary of the results is included in Table 6-1. The table includes (1) meteorological conditions as recorded on 2 days of ambient sampling; (2) ambient concentrations of Cr, Cu, and Pb as collected on filter samples both upwind and downwind at various distances and in one case an increased height above ground; (3) results of total dust concentrations as measured with an optical dust monitoring instrument; (4) results of the filter cassette analyses in the cab of the backhoe operator during excavation and loading of the sandblasting grit at HPA; and (5) dust concentration monitoring for one worker during the screening operation and two workers during asphaltic concrete production.

The total dust concentrations were very low at both upwind and downwind locations. It should be noted that the wind speed was also low during the entire time period. Only the personal samplers showed any significant dust concentrations and these were orders of magnitude below the Occupational Safety and Health Administration (OSHA)-regulated values for worker inert dust exposures.

The results for Pb, Cu, and Cr indicated that Pb, which is an ambient criteria pollutant, was consistently below the detection limits of the sampling method. Therefore, Pb exposure to workers or the surrounding population was insignificant under the conditions as tested.

Cr was detected in all five of the filters analyzed. However, there was no difference between any of the downwind samples and the upwind samples, indicating no increases in the Cr concentrations relative to the ambient air Cr concentrations in that area.

Cu was the only metal that showed an increase in one of the downwind samples relative to the upwind samples. It was unusual that the downwind sampler at a closer distance from the screening process had a significantly lower Cu concentration that the sampler at a greater distance (Table 6-1).

Table 6-1. Air Monitoring Data

METEOROLOGICAL CONDITIONS

TEST DATE:	19 Nov. 1991	22 Nov. 1991
AVG. WIND SPEED:	1.8 mph (0.56 m/s)	2.5 mph (1.1 m/s)
AVG. TEMPERATURE:	67°F (20°C)	60°F (16°C)
AVG. WIND DIRECTION:	West — 270°	North-Northwest — 330°

MONITORING/SAMPLER DATA

Date	Sampler I.D.	Location (relative to screen)	Distance/ Height (m) (m)	Sample Volume (m^3)	Total Dust (mg/m^3)	Chromium (mg/m^3)	Copper (mg/m^3)	Lead (mg/m^3)
Ambient Background Measurements								
19 Nov. 1991	440 BK	downwind	91 / 2	0.18	—	—	—	—
19 Nov. 1991	M.R. 4440	downwind	91 / 2	—	0.00	—	—	—
19 Nov. 1991	442 BK	downwind	91 / 5	0.18	—	0.0017	0.0011	<0.011
19 Nov. 1991	M.R. 4442	downwind	91 / 5	—	0.01	—	—	—
19 Nov. 1991	439 BK	upwind	— —	0.16	—	—	—	—
19 Nov. 1991	M.R. 4434	upwind	— —	—	0.00	—	—	—
Backhoe Operator During Grit Excavation and Loading at HPA								
20 Nov. 1991	HP-1	backhoe	operator	0.21	—	0.0014	0.00095	<0.0095
Dust Measurements During Grit Screening at Reed and Graham								
22 Nov. 1991	SCR-1	upwind	21	0.26	—	0.0016	<0.00077	<0.0077
22 Nov. 1991	M.R. 4443	upwind	21	—	0.00	—	—	—
22 Nov. 1991	M.R. 4439	upwind	personal	—	0.42	—	—	—
22 Nov. 1991	SCR-2	downwind	38 / 2	0.27	—	0.0011	0.0078	<0.0074
22 Nov. 1991	M.R. 4441	downwind	38 / 2	—	0.07	—	—	—

Table 6-1. Air Monitoring Data (continued)

METEOROLOGICAL CONDITIONS

TEST DATE:	19 Nov. 1991	22 Nov. 1991
AVG. WIND SPEED:	1.8 mph (0.56 m/s)	2.5 mph (1.1 m/s)
AVG. TEMPERATURE:	67°F (20°C)	60°F (16°C)
AVG. WIND DIRECTION:	West — 270°	North-Northwest — 330°

MONITORING/SAMPLER DATA

Date	Sampler I.D.	Location (relative to to screen)	Distance/ Height (m) (m)	Sample Volume (m^3)	Total Dust (mg/m^3)	Chromium (mg/m^3)	Copper (mg/m^3)	Lead (mg/m^3)
Dust Measurements During Grit Screening at Reed and Graham (Continued)								
22 Nov. 1991	M.R. 4442	downwind	personal	—	0.00	—	—	—
22 Nov. 1991	SCR-3	downwind	15	0.26	—	0.0012	0.00077	<0.0077
22 Nov. 1991	M.R. 4438	downwind	15	—	0.06	—	—	—
22 Nov. 1991	M.R. 4440	downwind	15	—	0.00	—	—	—
Dust Monitors on Workers During the Production of Asphalt at Reed and Graham								
23 Nov. 1991	M.R. 4441	hot plant	personal	—	0.11	—	—	—
23 Nov. 1991	M.R. 4443	hot plant	personal	—	0.01	—	—	—
Average (all)	—	—	—	—	0.06	0.0014	0.0023	—
(s.d.)	—	—	—	—	(0.12)	(0.0003)	(0.003)	—

However, there was no exceedance of the OSHA workplace level for Cu exposure in any of the samplers, including the personal sampler.

6.2 Results of Long-Term Testing of Chemical and Physical Performance of Pilot-Scale Test Strips

Chemical and physical tests were performed on the asphaltic concrete test specimens to determine compliance with California EPA "Use Constituting Disposal" policy criteria. A traffic count indicated that the traffic density on the inbound lane of the long-term test pavement was about 8 cars per hour. The results of these tests are provided below.

6.2.1 Long-Term Leaching Resistance of Pilot-Scale Test Strips

The three different types of asphalt were analyzed for total and WET-soluble Cu and Pb content to determine compliance with DTSC recycling criteria and also to calculate the average grit composition of the asphalt production runs containing untreated and treated grit. The analytical data are presented in Table 6-2.

The total metal data in Table 6-2 were evaluated in comparison with the average total metals content of the grit in Section 2, Table 2-4, as an approach to calculating the weight percent of grit that was added to the untreated and treated grit test strips. In Section 5.8 it was indicated that the grit concentration was about 5%, or slightly less based on the fact that approximately 1.5 tons of grit was incorporated into 30 tons or slightly more of asphaltic concrete. The weight percent grit content of the untreated or treated asphalt, A, was calculated from the following dilution calculation:

$$\frac{[X-Y]}{Z} * 100 = A$$

where X = the total Cu or Pb concentration in the asphaltic concrete test specimen (pellet or core, untreated or treated) from Table 6-2.

Y = the total Cu and Pb concentration in the control asphaltic concrete test specimen (pellet or core, untreated or treated) from Table 6-2.

Z = the mean total Cu or Pb concentration in the untreated or treated grit from Section 2, Table 2-4.

The results of these dilution calculations are provided in Table 6-3, and show that the average grit concentration in the untreated asphaltic concrete was 4.5 ± 1.6 weight percent and in the treated asphaltic concrete was 5.0 ± 1.4 weight percent. These values provide independent confirmation of the values estimated from the mass loading of sandblasting grit with the other asphaltic concrete ingredients.

The pilot-scale test strips placed on the south end of Fisher Avenue (Figure 5-1) in November 1991 remained in service. Three core samples were collected from each of the three test strips (untreated, sulfide-treated, and control) in June 1993. One year later, in June 1994, two additional core samples were cut from each of the three areas. These samples were analyzed for total and WET-soluble copper and lead. Core samples were collected for physical performance testing (see Section 6.2.2). The results for the June 1993 and June 1994 samples are shown in Tables 6-4 and 6-5, respectively.

Table 6-2. Results of Metals Analyses from Recycled Grit Asphaltic Concrete Pilot Test Strips, November 1991 Sampling

Sample ID	Total (mg/kg)		WET-Soluble (mg/L)	
	Cu	Pb	Cu	Pb
Control Asphalt Core	21	3.0	0.008	0.050
Control Lab Pellet	16	3.0	0.034	0.050
Untreated Asphalt Core	93	17	1.2	0.056
Untreated Lab Pellet	74	11	0.098	0.050
Loose Untreated	110	20	1.8	0.050
Sulfide-Treated Asphalt Core	62	10	0.69	0.097
Sulfide-Treated Lab Pellet	93	13	0.20	0.050
Loose Sulfide-Treated	76	9.8	0.42	0.07

Source: Means et al., 1993b, Table 4-1.

Table 6-3. Dilution Calculations for Determining Weight Percent Grit Used in Asphaltic Concrete

Total Threshold Limit Concentration			
(Y) Laboratory Control Pellet	**(X) Laboratory Untreated Pellet**	**(Z) Grit Concentration**	**Estimated Percent of Grit in Asphaltic Concrete**
Cu 16 mg/kg Pb 3.0 mg/kg	Cu 74 mg/kg Pb 11 mg/kg	1,832 mg/kg 204 mg/kg	3.2%[(a)] 3.9%[(a)]
Applied Control Core	**Applied Untreated Core**		**Estimated Percent of Grit in Asphaltic Concrete**
Cu 21 mg/kg	Cu 93 mg/kg	1,832 mg/kg	3.9%[(a)]
Pb 3.0 mg/kg	Pb 17 mg/kg	204 mg/kg	6.9%[(a)]
Laboratory Control Pellet	**Laboratory Sulfide-Treated Pellet**		**Estimated Percent of Grit in Asphaltic Concrete**
Cu 16 mg/kg Pb 3.0 mg/kg	Cu 93 mg/kg Pb 13 mg/kg	1,300 mg/kg 160 mg/kg	5.9%[(b)] 6.3%[(b)]
Applied Control Core	**Applied Sulfide-Treated Core**		**Estimated Percent of Grit in Asphaltic Concrete**
Cu 21 mg/kg Pb 3.0 mg/kg	Cu 62 mg/kg Pb 10 mg/kg	1,300 mg/kg 160 mg/kg	3.2%[(b)] 4.4%[(b)]

(a) Mean grit concentration of asphaltic concrete containing untreated grit = 4.5% ±1.6%.
(b) Mean grit concentration of asphaltic concrete containing treated grit = 5.0% ±1.4%.

Table 6-4. Results of Metals Analyses from Recycled Grit Asphaltic Concrete Pilot Test Strips, June 1993 Sampling

Sample	Total (mg/kg)		WET-Soluble (mg/L)	
	Cu	Pb	Cu	Pb
Untreated #1	70	18	0.69	0.14
Untreated #2	98	19	1.3	0.088
Untreated #3	90	22	0.21	0.23
Sulfide-Treated #1	47	12	0.88	0.073
Sulfide-Treated #2	85	14	0.44	0.18
Sulfide-Treated #3	25	11	0.49	0.068
Control #1	14	7.6	0.046	0.069
Control #2	17	8.8	0.067	0.073
Control #3	14	6.3	0.19	0.097

Source: Means et al., 1993b, Table 2-7.

Table 6-5. Results of Metals Analyses for Recycled Grit Asphaltic Concrete Pilot Test Strips, June 1994 Sampling[a]

Sample	Total (mg/kg)				WET-Soluble (mg/L)			
	Cu		Pb		Cu		Pb	
Untreated #1	51	55	9.3	9.4	<0.2	0.079	<0.5	0.059
Untreated #2	70	68	15	9.5	0.51	0.012	<0.5	0.069
Sulfide-Treated #1	36	50	10	12	<0.2	<0.01	<0.5	0.084
Sulfide-Treated #2	39	55	8.8	10	<0.2	<0.01	<0.5	0.072
Control #1	13	18	8.0	5.5	<0.2	<0.01	<0.5	<0.05
Control #2	13	29	4.8	4.7	<0.2	<0.01	<0.5	<0.05

(a) Left-hand column for each metal is inductively coupled plasma (ICP) analysis (Anlab, 8/94); right-hand column for each metal is graphite furnace analysis (Pace Mid-Pacific, 8/94).

6.2.2 Long-Term Physical Performance Testing of Pilot-Scale Test Strips

Physical properties measurements were obtained to determine compliance of the grit-containing asphaltic concrete with Caltrans standards. The physical properties test used was the ASTM D1560-81 (Hveem Method). Data collected from the Hveem Method include (1) bitumen or asphalt content, (2) stabilimeter value, (3) cohesiometer value, (4) test temperature, (5) density of asphalt-treated grit mixture, and (6) air voids ratio. The Hveem tests are described in Section 4.2.2.

Samples of asphalt were collected during manufacture of the control, untreated grit, and sulfite-treated grit asphalt for the pilot-scale test strip preparation in November 1991. One core sample was taken from each of the three long-term test strips shortly after the strips were laid.

Results for the physical tests for standard asphaltic concrete (control), asphaltic concrete containing untreated grit, and asphaltic concrete containing treated grit are presented in Table 6-6. A decrease in stabilimeter value was observed for the untreated and sulfide-treated field cores. These samples failed the minimum criteria for stabilimeter values for medium-traffic conditions; however, the laboratory-manufactured cores made from the same asphalt mixture meet the stabilimeter value criteria. The oil content in the field cores was observed to be higher than the oil content in the lab cores. The higher oil content in the field cores is believed to be caused from the tack coat and fog seal that were applied before and after asphalt application. Higher oil contents in test specimens will cause stabilimeter values to be lower. These oils will volatilize with time and the stabilimeter values for the untreated and sulfide-treated field cores are expected to increase and meet Caltrans specifications. This hypothesis was tested by collecting samples later to allow repetition of physical and chemical analysis. Cohesiometer values and swell tests results for all the samples submitted exceeded the minimum test limit criteria. The percent voids values were lower than normally encountered, likely because of the high temperatures upon arrival at HPA and the prompt and thorough compaction through rolling. Such low percent voids values typically are associated with very-high-integrity asphalt and would not be viewed negatively but are not always achieved in the commercial paving industry because there is usually a greater extent of cooling between asphalt production and compaction.

The long-term performance of asphaltic concrete made using spent sandblasting grit as a portion of the aggregate was determined by taking and testing additional core samples. Three core samples were collected from each of the test areas in June of 1993. Two more core samples were collected from each of the test areas in June of 1994. Cores also were collected for chemical testing (see Section 6.2.1). The test results from the long-term core samples from June 1993 and June 1994 are shown in Tables 6-7 and 6-8, respectively.

6.3 Compliance with California STLC and Physical Performance Criteria

Calculations can be performed to determine compliance of the asphalt with California STLC requirements after subtracting the background contribution and correcting for the effect of dilution. Table 6-9 presents the results of the calculations for Pb in asphalt strips containing untreated grit. The average WET (leachable) Pb content of the untreated grit was 19 mg/L, compared to an STLC of 5 mg/L. Therefore, the asphalt binder ingredients would need to immobilize the Pb by a factor of approximately four to bring the WET Pb content of the spent sandblasting grit in the asphaltic concrete to below 5 mg/L. Based on analysis of the core samples, the average WET Pb content of the sandblasting grit-containing asphaltic concrete was 0.13 mg/L, versus 0.07 mg/L for control asphalt specimens containing the same aggregate and oil contents, but no sandblasting grit, thus indicating a WET Pb content of 0.06 mg/L attributable of the sandblasting grit component of the asphalt. The grit content of the asphaltic concrete was 5.0%, indicating a dilution factor of 20 which, when multiplied by the background-corrected WET Pb content of the asphaltic concrete, yields 1.2 mg/L Pb. This value is well below the STLC criterion for Pb, 5 mg/L, thus indicating compliance with the criterion. Tables 6-12, 6-13, and 6-14 present similar calculations for Cu and Pb for asphaltic concrete samples containing both treated and untreated grit. In all cases, the STLC criteria have been met. The results for the June 1994 sampling are not included in this example calculation because the majority of the

Table 6-6. Recycled Grit Asphaltic Concrete Physical Performance Tests, November 1991 Pilot Test Sampling

Test Performed	Lab Control	Control Field Core	Lab Untreated	Untreated Field Core	Lab Sulfide-Treated	Sulfide-Treated Field Core	Acceptance Criteria
Percent Oil by Weight of Aggregate (%)	5.4	5.4	5.3	6.2	4.9	5.7	
Percent Oil by Weight of Mix (%)	5.2	5.1	5.0	5.8	4.7	5.4	
Maximum Theoretical Unit Weight (ASTM D-2041) (PCF)	153.8	154.3	154.6	153.3	155.0	154.2	
Laboratory-Compacted Unit Weight (PCF)	150.8	149.6	150.7	150.5	150.6	151.3	
Percent Voids (%)	1.9	3.0	2.6	1.9	2.9	1.9	4 (min)(-)8 (max)[a]
Hveem Stabilimeter Value	36	41	39	27	37	29	35 (min)[b]
Compacted Appearance of Hveem Specimens	flushing	slt. flushing	flushing	flushing	flushing	flushing	
Swell (CA 305) (in)	0.000	0.000	0.000	0.000	0.000	0.000	0.030 in (max)
Cohesiometer (CA 306)	430	494	406	420	476	425	50 (min)[c]

(a) Asphalt Institute (1962) criteria; minimum value for Hveem test, maximum value as listed for Marshall test. Note that there is no maximum % voids value for the Hveem test in the Asphalt Institute (1962) criteria.
(b) Caltrans criterion for medium-traffic applications.
(c) Asphalt Institute (1962) criteria.
PCF = pounds per cubic foot.

Table 6-7. Recycled Grit Asphaltic Concrete Tests, June 1993 Pilot Test Sampling

Test Performed	Control #1	Control #2	Control #3	Untreated #1	Untreated #2	Untreated #3	Sulfide-Treated #1	Sulfide-Treated #2	Sulfide-Treated #3	Acceptance Criteria
Percent Oil by Weight of Aggregate (%)	5.8	6.2	6.1	5.9	5.4	6.0	6.1	6.6	6.2	
Percent Oil by Weight of Mix (%)	5.5	5.8	5.8	5.6	5.2	5.6	5.7	6.2	5.8	
Maximum Theoretical Unit Weight (ASTM D-2041) (PCF)	154.5	153.7	154.6	155.0	155.6	155.2	154.7	153.7	154.1	
Laboratory-Compacted Unit Weight (PCF)	150.1	150.5	151.2	150.6	150.8	150.8	150.3	151.1	151.8	
Percent Voids (%)	2.8	2.1	2.2	2.8	3.1	2.8	2.8	1.7	1.5	4 (min)(-) 8 (max)[a]
Hveem Stabilimeter Value	37	22	32	41	35	32	32	21	17	35 (min)[b]
Compacted Appearance of Hveem Specimens	moderate flushing	flushing & pumping	flushing	moderate flushing	very slight flushing	moderate flushing	flushing	flushing & pumping	flushing & pumping	
Swell (CA 305) (in)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030 in (max)
Cohesiometer (CA 306)	542	343	503	505	455	480	405	377	155	50 (min)[c]

(a) Asphalt Institute (1962) criteria; minimum value of Hveem test, maximum value as listed for Marshall Test. Note that there is no maximum percent voids value for the Hveem test in the Asphalt Institute (1962) criteria.
(b) Caltrans criterion for medium-traffic applications.
(c) Asphalt Institute (1962) criteria.
PCF = pounds per cubic foot.
Source: Means et al., 1993b, Table 2-9.

Table 6-8. Recycled Grit Asphaltic Concrete Physical Performance Tests, June 1994 Pilot Test Sampling

Test Performed	Control #1	Control #2	Untreated #1	Untreated #2	Sulfide-Treated #1	Sulfide-Treated #2	Acceptance Criteria
Percent Oil by Weight of Aggregate (%)	5.4	6.1	5.1	5.9	5.5	5.3	
Percent Oil by Weight of Mix (%)	5.2	5.8	49	5.6	5.2	5.0	
Maximum Theoretical Unit Weight (ASTM D-2041) (PCF)	155.7	153.8	155.6	154.9	155.9	155.3	
Laboratory-Compacted Unit Weight (PCF)	149.0	151.1	150.9	149.2	151.9	150.2	
Percent Voids (%)	4.3	1.8	3.0	3.7	2.5	3.3	4 (min)(-)8 (max)[a]
Hveem Stabilimeter Value	41	28	40	45	40	45	35 (min)[b]
Compacted Appearance of Hveem Specimens	stable	flushing & pumping	slight flushing	stable	flushing	slight flushing	
Swell (CA 305) (in)	0.000	0.000	0.000	0.000	0.000	0.000	0.030 in (max)
Cohesiometer (CA 306)	402	220	331	460	487	495	50 (min)[c]

(a) Asphalt Institute (1962) criteria; minimum value for Hveem test, maximum value as listed for Marshall test. Note that there is no maximum percent voids value for the Hveem test in the Asphalt Institute (1962) criteria.
(b) Caltrans criterion for medium-traffic applications.
(c) Asphalt Institute (1962) criteria.
PCF = pounds per cubic foot.

Table 6-9. Calculations for Pb in Asphaltic Concrete Test Strips Containing Untreated Grit

Mean Total Pb Content of Grit	204 mg/kg
Mean WET Pb Content of Grit	19 mg/L
A) WET Pb Content of Asphalt Test Strips (average of 4 values for field cores from 1991 and 1993 sampling)	0.13 mg/L
B) WET Pb Content of Control Asphalt Test Strips (average of 4 values for field cores from 1991 to 1993 sampling)	0.07 mg/L
C) Background-Corrected WET Pb Content of Asphalt Test Strips (A−B)	0.06 mg/L
D) Dilution Factor — Untreated Test Strips	20
E) Dilution-Corrected WET Pb Content of Asphalt Test Strips (C × D)	1.2 mg/L
F) STLC for Pb	5.0 mg/L

Table 6-10. Calculations for Cu in Asphaltic Concrete Test Strips Containing Untreated Grit

Mean Total Cu Content of Grit	1,832 mg/kg
Mean WET Cu Content of Grit	144 mg/L
A) WET Cu Content of Asphalt Test Strips (average of 4 values for field cores from 1991 and 1993 sampling)	0.85 mg/L
B) WET Cu Content of Control Asphalt Test Strips (average of 4 values for field cores from 1991 to 1993 sampling)	0.10 mg/L
C) Background-Corrected WET Cu Content of Asphalt Test Strips (A−B)	0.75 mg/L
D) Dilution Factor — Untreated Test Strips	20
E) Dilution-Corrected WET Cu Content of Asphalt Test Strips (C × D)	15 mg/L
F) STLC for Cu	25 mg/L

analyses indicated leachable Cu and Pb concentrations below the detection limit. The results for June 1994 showed no significant change in total metal content and a possible reduction in copper and lead leachability. The decrease in metal leachability may be due to slow changes in the physico-chemical form of the metals, i.e., gradual immobilization of Cu and Pb in the asphalt matrix.

The long-term pilot-scale testing indicates that the use of the sandblasting grit in asphalt paving is a viable option under the California waste management memo (Appendix C). The sand-blasting grit provides value as aggregate in the asphalt while the asphalt assists in immobilizing metal contaminants.

Table 6-11. Calculations for Pb in Asphaltic Concrete Test Strips Containing Sulfide-Treated Grit

Mean Total Pb Content of Grit	160 mg/kg
Mean WET Pb Content of Grit	11.1 mg/L
A) WET Pb Content of Asphalt Test Strips (average of 4 values for field cores from 1991 and 1993 sampling)	0.10 mg/L
B) WET Pb Content of Control Asphalt Test Strips (average of 4 values for field cores from 1991 to 1993 sampling)	0.07 mg/L
C) Background-Corrected WET Pb Content of Asphalt Test Strips (A−B)	0.03 mg/L
D) Dilution Factor — Untreated Test Strips	22
E) Dilution-Corrected WET Pb Content of Asphalt Test Strips (C × D)	0.66 mg/L
F) STLC for Pb	5.0 mg/L

Table 6-12. Calculations for Cu in Asphaltic Concrete Test Strips Containing Sulfide-Treated Grit

Mean Total Cu Content of Grit	1,300 mg/kg
Mean WET Cu Content of Grit	55.5 mg/L
A) WET Cu Content of Asphalt Test Strips (average of 4 values for field cores from 1991 and 1993 sampling)	0.63 mg/L
B) WET Cu Content of Control Asphalt Test Strips (average of 4 values for field cores from 1991 to 1993 sampling)	0.10 mg/L
C) Background-Corrected WET Cu Content of Asphalt Test Strips (A−B)	0.53 mg/L
D) Dilution Factor — Untreated Test Strips	22
E) Dilution-Corrected WET Cu Content of Asphalt Test Strips (C × D)	11.7 mg/L
F) STLC for Cu	25 mg/L

Several performance parameters are tabulated as a function of time to allow examination of the effects of weathering on asphaltic concrete made with untreated grit (Table 6-13) and treated grit (Table 6-14). The general trend is as expected showing a slow decrease in percent oil while percent voids and Hveem stabilimeter values increased. Stabilimeter values were within the test limit criteria for asphalt made from both types of grit for all of the June 1994 samples. The percent voids were still low but, as discussed in Section 6.2, the low percent voids is reasonable given the asphalt temperature at the time of placement and is not an indicator of poor quality asphalt. The trend of all physical performance parameters indicates good quality paving showing normal weathering and aging effects.

Table 6-13. Comparison of Physical Performance Data for Asphaltic Concrete Made with Untreated Grit

	Averaged Long-Term Results			
	November 1991	**June 1993[a]**	**June 1994[b]**	**Acceptance Criteria**
Percent Oil by Weight of Mix (%)	5.8	5.5	5.3	
Percent Voids (%)	1.9	2.9	3.4	4 (min) 8 (max)
Hveem Stabilimeter Value	27	36	42.5	35 (min)
Swell (CA 305) (in)	0.000	0.000	0.000	0.030 (max)
Cohesiometer (CA 306)	420	480	400	50 (min)

(a) Average of three values (Table 6-7).
(b) Average of two values (Table 6-8).

Table 6-14. Comparison of Physical Performance Data for Asphaltic Concrete Made with Sulfide-Treated Grit

	Averaged Long-Term Results			
	November 1991	**June 1993[a]**	**June 1994[b]**	**Acceptance Criteria**
Percent Oil by Weight of Mix (%)	5.4	5.9	5.2	
Percent Voids (%)	1.9	2.0	2.9	4 (min) 8 (max)
Hveem Stabilimeter Value	29	23	43	35 (min)
Swell (CA 305) (in)	0.000	0.000	0.000	0.030 (max)
Cohesiometer (CA 306)	425	312	491	50 (min)

(a) Average of three values (Table 6-7).
(b) Average of two values (Table 6-8).

6.4 Roadgrinding Test Activities and Results

Recycling asphaltic concrete paving is a common practice in the United States. In 1992, for example, more than 12,000,000 tons of asphalt was ground and reused for new paving (ARRA, 1994). Asphalt paving recycling requires breaking or grinding the old road surface, an operation that generates dust. Grinding old pavement made from asphalt containing spent sandblasting grit as part of the aggregate raises concerns about possible elevated metal levels in dust generated by the road-grinding operation.

6.4.1 Roadgrinding Test Methods

On July 13, 1993, a test was conducted to determine the quantity and metal composition of dust emissions generated from asphaltic concrete paving material during roadgrinding operations. The roadgrinding test indicated that there is no difference in metal contaminant exposures experienced by the grinder operator between the dust generated from the control strips and strips containing the sulfide-treated or untreated grit and, in all cases, the Cu, Cr, and Pb exposures are well below prescribed limits.

Three asphaltic concrete test strips were produced and laid at HPA in November 1991 for subsequent use in the roadgrinding test (see Section 5.9). Two of these strips were produced using each of the two different types of sandblasting grits produced at HPA, i.e., untreated grit and sulfide-treated grit, as part of the aggregate. The third test strip, a control, was produced out of normal aggregate materials used in paving. Figure 6-1 shows the layout of the three 10-ft-wide by 50-ft-long strips on the western edge of Spear Avenue just north of the intersection of Cochrane Street.

On July 19, 1993, the standard roadgrinding operation used to remove old or deteriorating asphaltic concrete prior to repaving was simulated (see Photo 6-1). The simulation involved the following steps:

1. A mechanical planing machine removed the approximately 2-in-thick lifts of test strip material.

2. A sweeping machine collected the debris for recycling to an asphalt plant for use as aggregate in future paving operations.

The simulation was conducted by Anrak Inc. of San Carlos, California, a major Bay-area construction firm.

Aerosol and dust measurements were taken with aerosol collection apparatus during the simulated grinding and sweeping. Measurements in the immediate area of the roadgrinding apparatus and operator as well as at two different points downwind from the operator were taken to determine personal and residential exposure potential. A meteorological station was installed to monitor wind speed and direction (see Photo 6-2). One upwind measurement was taken to establish a baseline. Analyses included total dust by mass and the total Cu, Cr, and Pb contents of the dust. The analytical data were modeled to evaluate the potential occupational and public risk of exposure to grinding asphalt containing low levels of sandblasting grit. Risks to potential receptors were characterized and evaluated in terms of regulatory exposure thresholds.

6.4.2 Roadgrinding Test Results

6.4.2.1 Personal Exposure Monitoring. Table 6-15 shows the aerosol mass concentrations and metals concentrations measured during the roadgrinding simulation. Measurable dust levels were collected when the roadgrinder operator's breathing zone was monitored. The concentrations of all three metals (Cr, Cu, and Pb) were below detection limits. The total dust concentrations measured with the personal sampler during grinding of the three strips were 6.2, 12.2, and 16.3 mg/m^3. These concentrations can be compared to the upwind particulate concentration of 0.2 mg/m^3. Variations in the microclimate of the grinder operator during the short sampling periods may have resulted in the substantial short-term variations in exposure levels to dust concentrations. For a longer sampling period, such as an 8-hour shift, these variations would be greatly reduced, eliminating the possibility that these variations were caused by any differences in the asphalts processed.

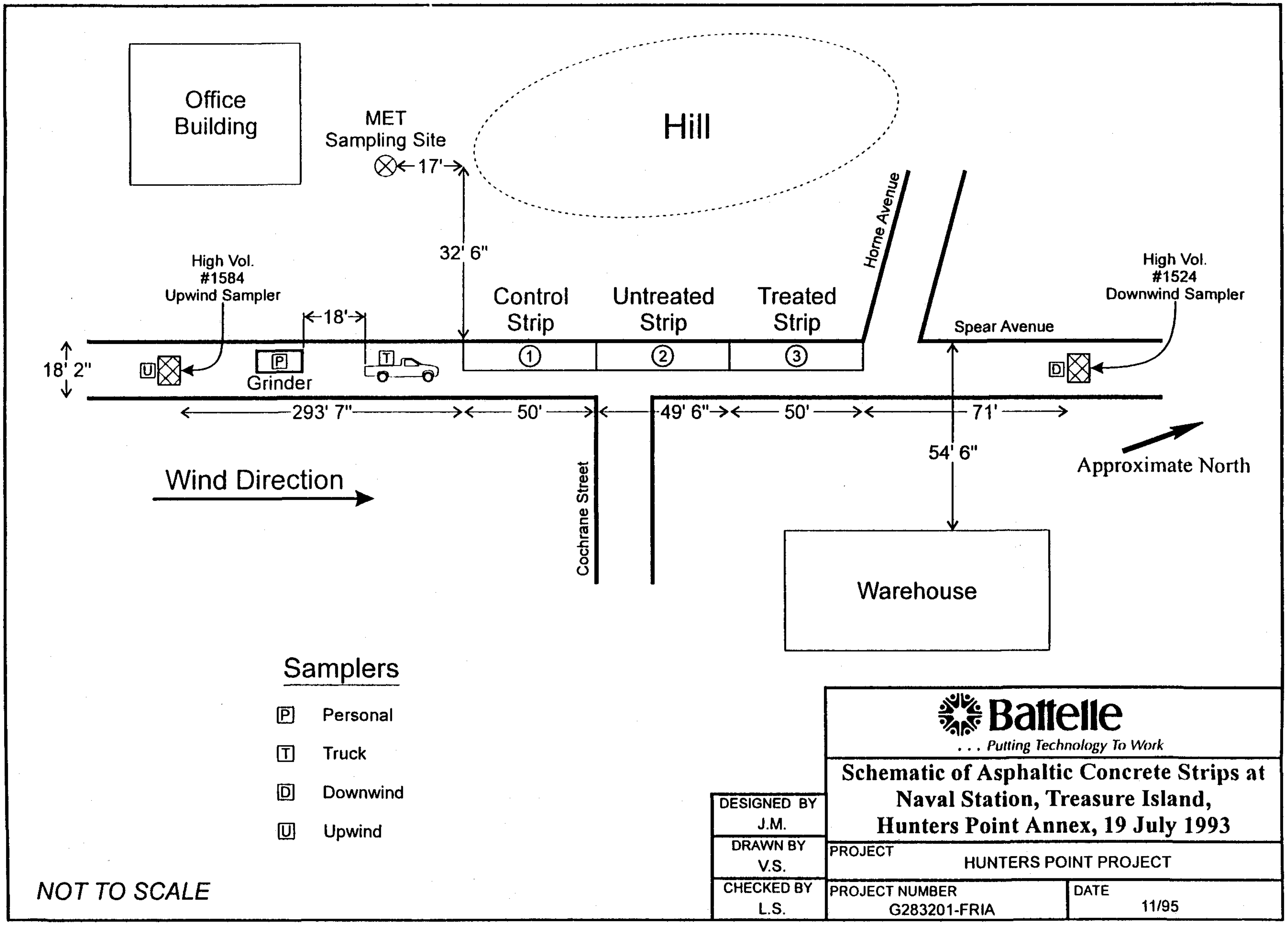


Figure 6-1. Schematic Map of Asphaltic Concrete Strips at Naval Station, Treasure Island, Hunters Point Annex, 19 July 1993.

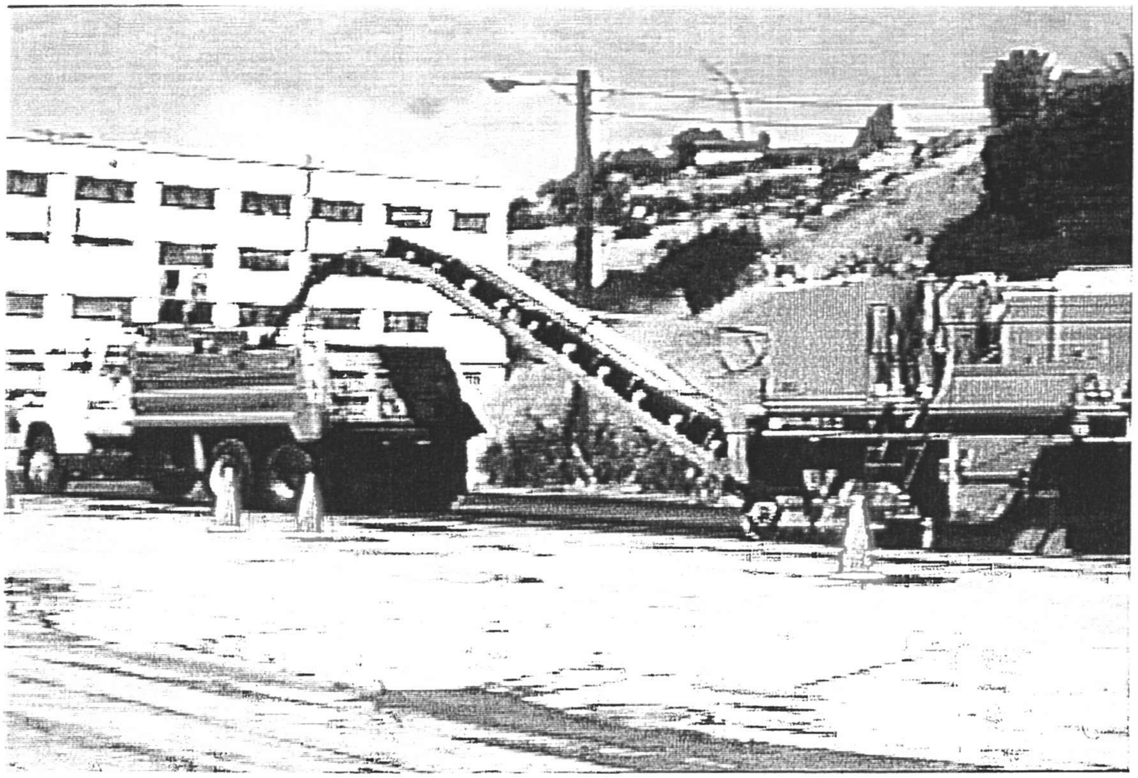


Photo 6-1. Roadgrinding operations at Hunters Point Annex test strips.

The total dust concentration values measured would indicate that worker exposure could exceed the threshold limit value (TLV) for dust (10 mg/m^3) for any of the test strips processed, if grinding operations were continuous through an 8-hour shift.

Actually exceeding the total dust TLV in normal practice is, however, unlikely due to the following two factors:

1. The sampling was conducted only during the actual grinding operation and cannot be extrapolated to a complete work shift without accounting for the fact that the grinding is intermittent. Intermittent grinding presumably would result in a lower average exposure for the operator during an 8-hour shift.

2. The results presented here are greatly affected by the prevailing wind conditions. The ambient meteorological conditions for this test were not unusual, but extrapolation to exposures under other conditions is not reliable.

Direct measurement of the metal exposure experienced by the roadgrinder operator was not possible. However, it was possible to estimate the concentrations of Cr, Cu, and Pb received by the operator. One can reasonably assume that the metals content of the particles collected by the down-wind high-volume sampler is the same as that for the particles collected by the personal sampler, because both are collecting emissions from the same sources. With that assumption, the average Cr, Cu, and Pb fraction measured on the high-volume samples can be used to estimate the metal concentrations for the personal sampler. The average fractions of the metals in the particle samples

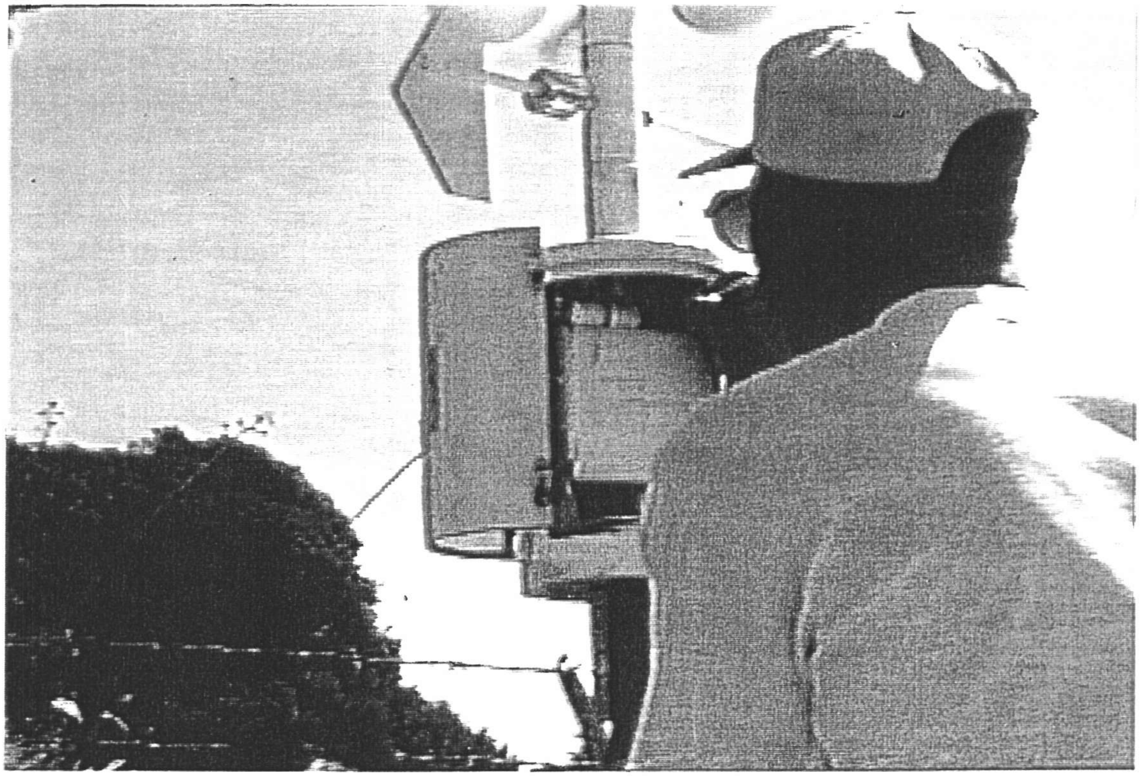


Photo 6-2. Meteorological monitoring during roadgrinding test at Hunters Point Annex.

collected on the "truck" and downwind high-volume samplers were Cr = 2.2 E-4, Cu = 1.7 E-4, and Pb = 1.1 E-4. The estimate the metals concentrations from the peroneal sampler, the total dust concentration values were multiplied by these factors. This calculation yields an average exposure level of Cr = 2.5 $\mu g/m^3$, Cu = 2.0 $\mu g/m^3$, and Pb = 1.3 $\mu g/m^3$.

To provide a frame of reference, these exposure values can be compared to the time-weighted average (TWA) exposure limits of 1 mg/m^3 for Cr dust and for Cu dust, and 50 mg/m^3 for Pb dust. Clearly, the measured exposure values are well below the prescribed limits.

Finally, it should be noted that no difference was detected between the metal exposures received by the grinder operator and the dusts generated from the control asphalt and from the strips containing treated or untreated grit.

6.4.2.2 Residential Exposure Potential. The 3-hour average total dust mass concentration upwind of the grinder due to the grinding of the treated strip was approximately the same as that measured downwind of the control and untreated strips. The grinding of the strip made with sulfide-treated grit in the aggregate resulted in a noticeably higher (about 1 order of magnitude) total dust concentration downwind of the grinder. However, the downwind sampler was located much closer to the sulfide-treated grit strip than to either the control strip or the untreated grit strip. The truck samples resulting from all three strips indicate 1.5 mg/m^3 of total dust concentration of roughly 6 meters from the source. However, for the control strip, the test operator believes that the truck was not positioned as well for collection of dust emissions as it was for the samples from the other two strips.

Table 6-15. Aerosol Mass Concentrations and Metals Concentrations Measured During Roadgrinding Operations at Hunters Point Annex, 19 July 1993

Asphalt Test Strip	Test #	Filter[a]	Mass (mg)	Total Volume (m^3)	Mass Concentration (mg/m^3)	Chromium ($\mu g/m^3$)	Copper ($\mu g/m^3$)	Lead ($\mu g/m^3$)
Control	1	T 61	20	23.8	0.8	0.304	0.096	0.062
	1	D 62	2.4	26.9	0.1	0.062	0.060	0.027
	1	P 21	0.305	0.0495	6.2	ND[c]	ND[c]	ND[c]
Untreated	2	T 64	33.6	22.3	1.5	0.105	0.132	0.069
	2	D 65	7.4	20.2	0.4	0.040	-0.013	0.026
	2	P 22	0.439	0.0269	16.3	ND[c]	ND[c]	ND[c]
Sulfide-Treated	3	T 67	33.5	22.3	1.5	0.102	0.132	0.105
	3	D 66	31.4	20.2	1.6	0.126	0.179	0.222
	3	U 63[b]	37.1	188	0.2	0.011	0.048	0.052
	3	P 23	0.437	0.0357	12.2	ND[c]	ND[c]	ND[c]

(a) P = Personal; T = Truck; D = Downwind; U = Upwind.
(b) The upwind filter sampled throughout the three test periods.
(c) All metals below detection limits on all personal filter samples.

Upwind samples were used to indicate the background concentrations of the three metals (Cr, Cu, and Pb) to determine their concentrations resulting from roadgrinding. In all cases, the metal concentrations were so low that the high-volume filter segments had to be resubmitted for analysis to obtain detectable masses. The truck samples indicate a slightly higher chromium level in the control strip, but otherwise there is not much difference in the dust emissions from the three strips.

A model using simple Gaussian plan dispersion was set up to calculate the metals concentrations in areas surrounding the roadgrinding operations. The Gaussian model for a ground-level concentration from a continuous source, which in this case is the roadgrinder, is as follows:

$$\chi(x,y) = \frac{Q}{\pi \sigma_y \sigma_z u} \exp \left[-\frac{1}{2} \left(\frac{y}{\sigma_y} \right)^2 \right]$$

where χ = concentration, g/m^3
x = downwind distance to a receptor, m
y = crosswind distance to a receptor, m
Q = uniform emission rate, g/s
σ_y, σ_z = horizontal and vertical dispersion coefficients, which are functions of x and atmospheric stability class, m (from Table 6-16)
u = mean wind speed, m/s.

Based on calculations using the Gaussian dispersion equation and concentration measurements from the downwind high-volume sampler, the continuous source used in the model is set conservatively at a constant 1 gram of airborne dust per second.

The Gaussian model can be used to determine the metals concentrations as a function of the downwind distance, x, as well as the crosswind distance, y, of the receptor to the source. Figure 6-2 shows the dust concentrations for a receptor located 50 m downwind from the source for a wind velocity of 5 m/s calculated using the Gaussian model. Note that when the receptor is directly downwind of the source (y = 0), the concentration is highest. Because the source (roadgrinder) is not fixed, but is a likely receptor, the concentration versus distance curve can be used to calculate an average dust exposure in mg/m^3. The calculated average is 95% of the total area under the curve divided by the distance y over which this area occurs.

By taking the maximum of each metal's percentage of dust concentration from the truck and downwind samplers for all three strips, and by calculating the average dust exposures for different

Table 6-16. Calculated Source Strengths for Pasquill Stability Classes B and C

Test Strips	Distance (m)	Class B		Q_b (mg/s)	Class C		Q_c (mg/s)
		σ_y (m)	σ_z (m)		σ_y (m)	σ_z (m)	
Control	59.8	10.2	6.6	630	8	4.5	340
Untreated	44.5	9	4.9	1,700	6.2	3.5	850
Sulfide-treated	29.3	6	3.3	3,200	4.3	2.4	1,700

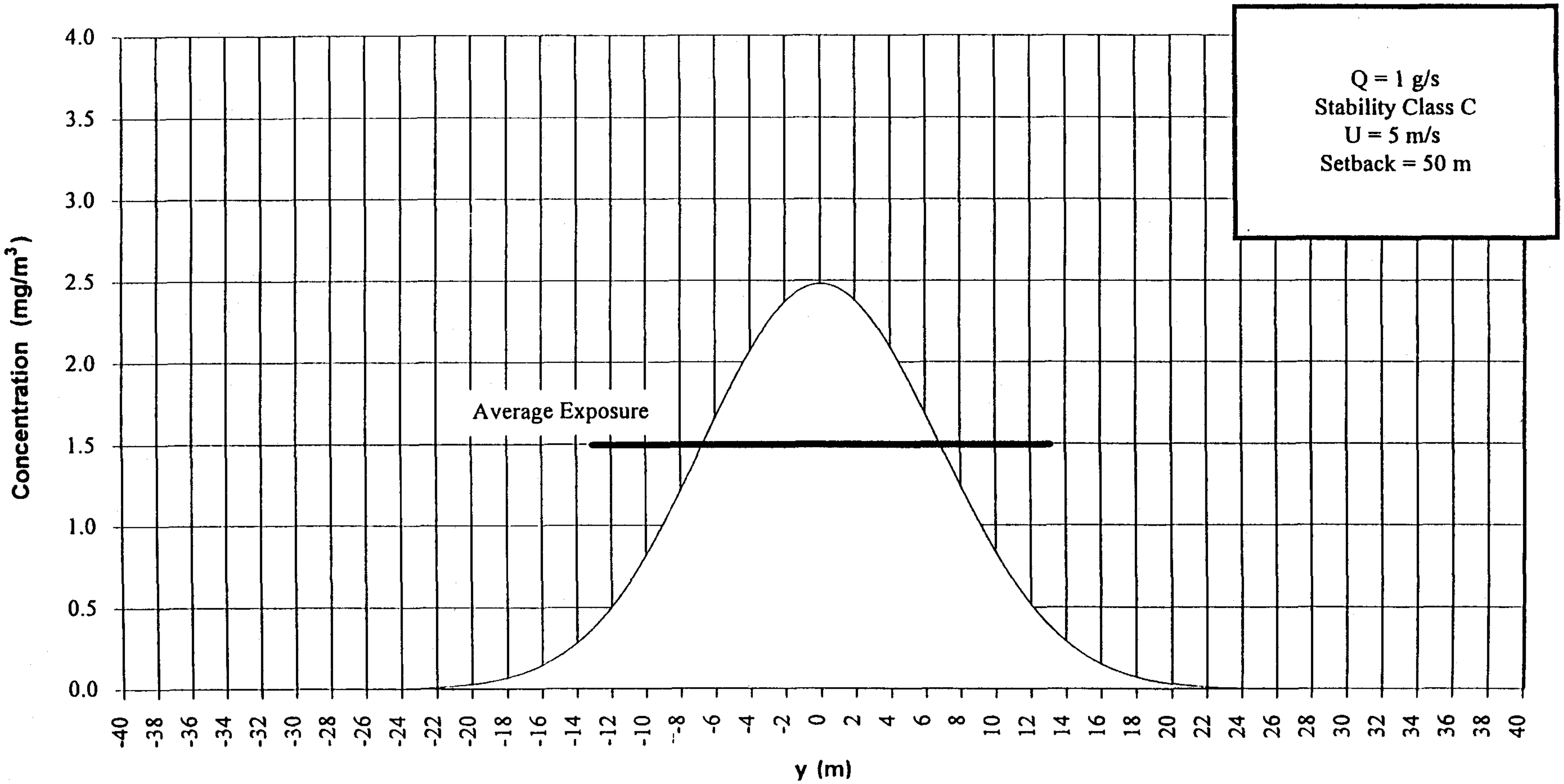


Figure 6-2. Dust Concentrations (mg/m³) for a Receptor Located 50 m Downwind from the Source for a Wind Velocity of 5 m/s.

values of downwind distances, the amounts of metals concentrations may be determined. The maximum percentages of dust concentrations for Cu, Cr, and Pb were experimentally determined to be 0.060%, 0.062%, and 0.027%, respectively. By applying these percentages to the average dust exposures over varying downwind receptor distances, assuming uniform velocities of 2 and 5 m/s, and by calculating the 8-hour TWAs for the concentrations of each of the metals, the graphs shown in Figures 6-3 and 6-4 were produced. It is evident from these figures that the computed average exposures for all three metals fall well below the regulation 8-hour TWA exposures. To display the metals concentrations on a per ton of ground asphalt basis, the graphs were normalized as shown in Figures 6-5 and 6-6. These normalized curves assume a grinder with a width of 10 feet and a lift of 2 inches that has ground a 50-foot strip of asphalt, as was the case in the experiment.

6.4.3 Implications of the Roadgrinding Test

In measurements of personal exposure to the roadgrinder operator, the total dust concentrations during grinding of all three of the strips were higher than the upwind particulate concentration of 0.2 mg/m^3. The total dust exposure was higher during grinding of the control test strip, but the variation is more likely to be due to wind conditions than to any difference in the asphalts processed. The variations of the microclimate of the grinder operator during the short sampling periods result in substantial short-term variations in exposure levels. For a longer sampling period, such as an 8-hour shift, much less variation would be seen.

The total dust concentration values measured indicate that worker exposure could exceed the TLV for dust (10 mg/m^3) during grinding operations for any of the asphalts processed, if the grinding proceeded continuously for a full 8-hour shift. The total dust concentration results cannot be extrapolated to a complete work shift without accounting for the fact that the grinding is intermittent, because the sampling was conducted only during the actual grinding operation (see Photo 6-3). Intermittent operation would result in a lower average exposure for the operator during an 8-hour shift. Furthermore, the results presented here are greatly affected by the prevailing wind conditions. Although the ambient meteorological conditions for this test were not unusual, extrapolation to exposures under other conditions would not be reliable.

There was no difference in the metal exposures experienced by the grinder operator between the dusts generated from the control asphalt and those strips containing the treated or untreated grit, and the estimated concentrations of Cu, Cr, and Pb received by the operator are well below the prescribed limits.

In the measurements and calculations of residential exposure potential, although the 3-hour average total dust mass concentration upwind of the grinder was approximately the same as that measured downwind of the control and untreated strips, the grinding of the treated strip results in a noticeably higher total dust concentration downwind of the grinder. The difference may be attributed in part to the fact that the downwind sampler is much closer to the treated strip than to either the control strip or the untreated strip. As for the truck samples, the truck may not have been positioned as well for collection of dust emissions as it was for the other two strip's samples.

The analytical results of the calculations showed that when the receptor is directly downwind of the source, the concentration is highest. When the curve was modified to give an average dust exposure for a non-fixed source, the computed average exposures for all three metals also fell well below the regulatory 8-hour TWA exposures.

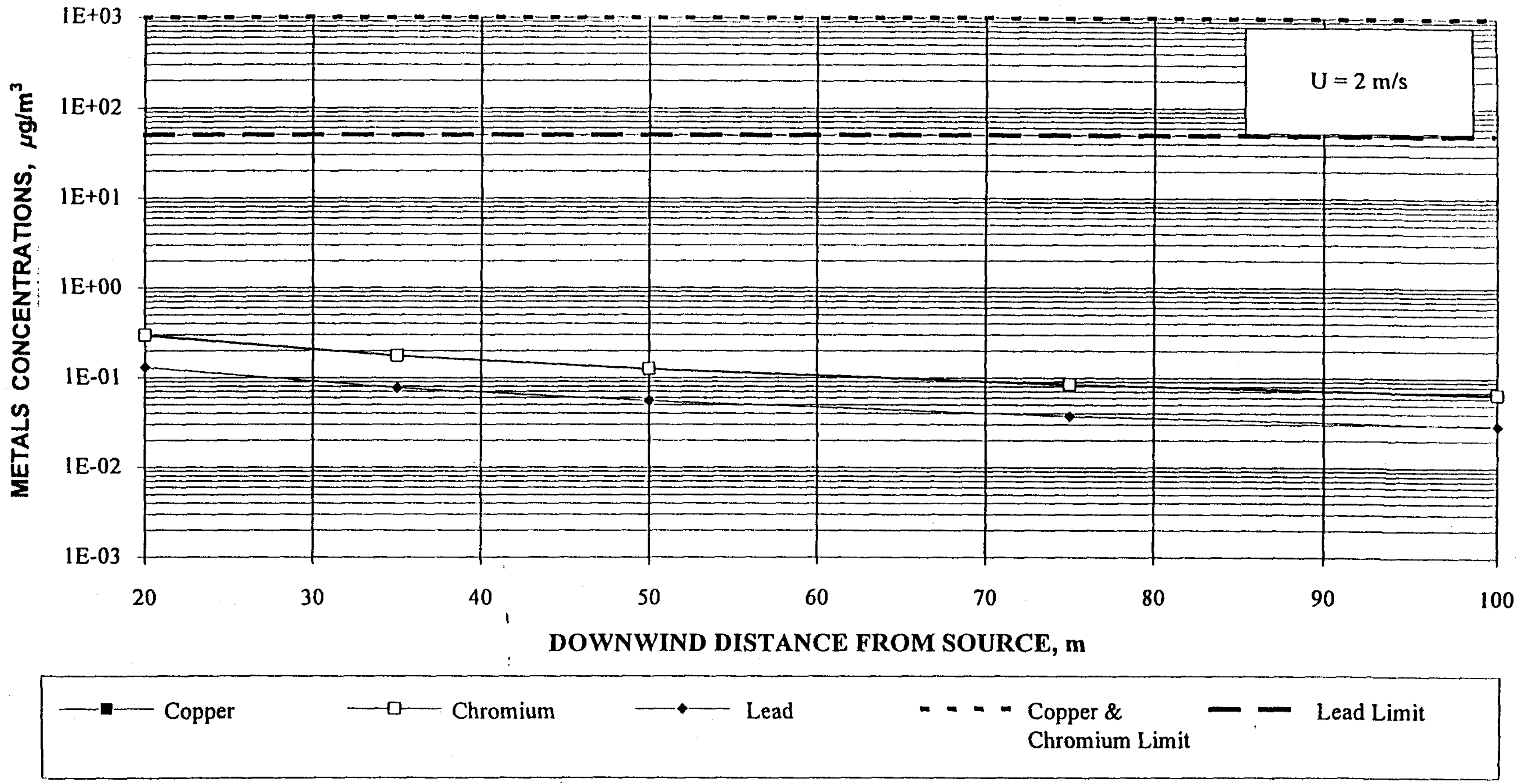


Figure 6-3. Metals Concentrations ($\mu g/m^3$) Assuming a Uniform Velocity of 2 m/s.

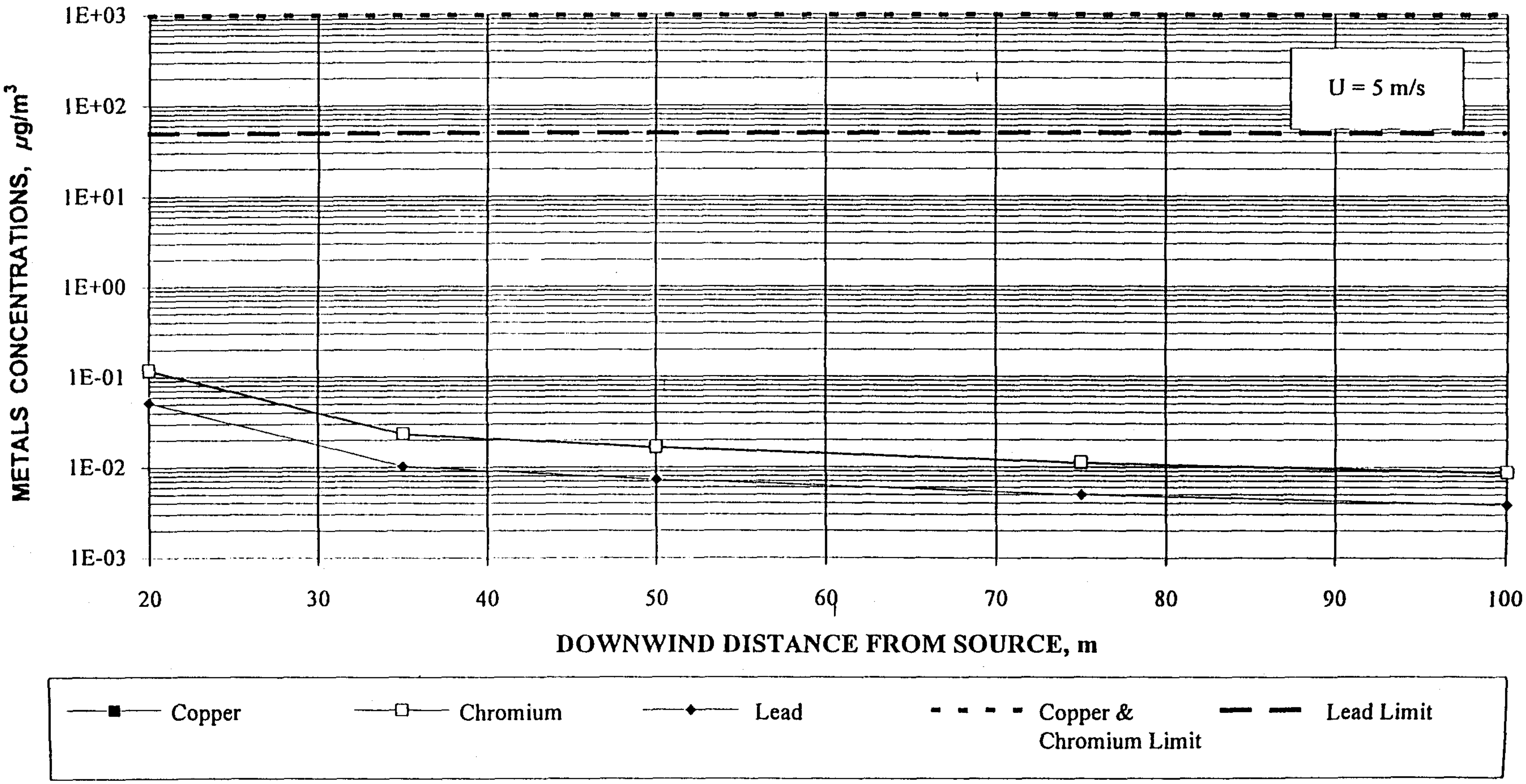


Figure 6-4. Metals Concentrations ($\mu g/m^3$) Assuming a Uniform Velocity of 5 m/s.

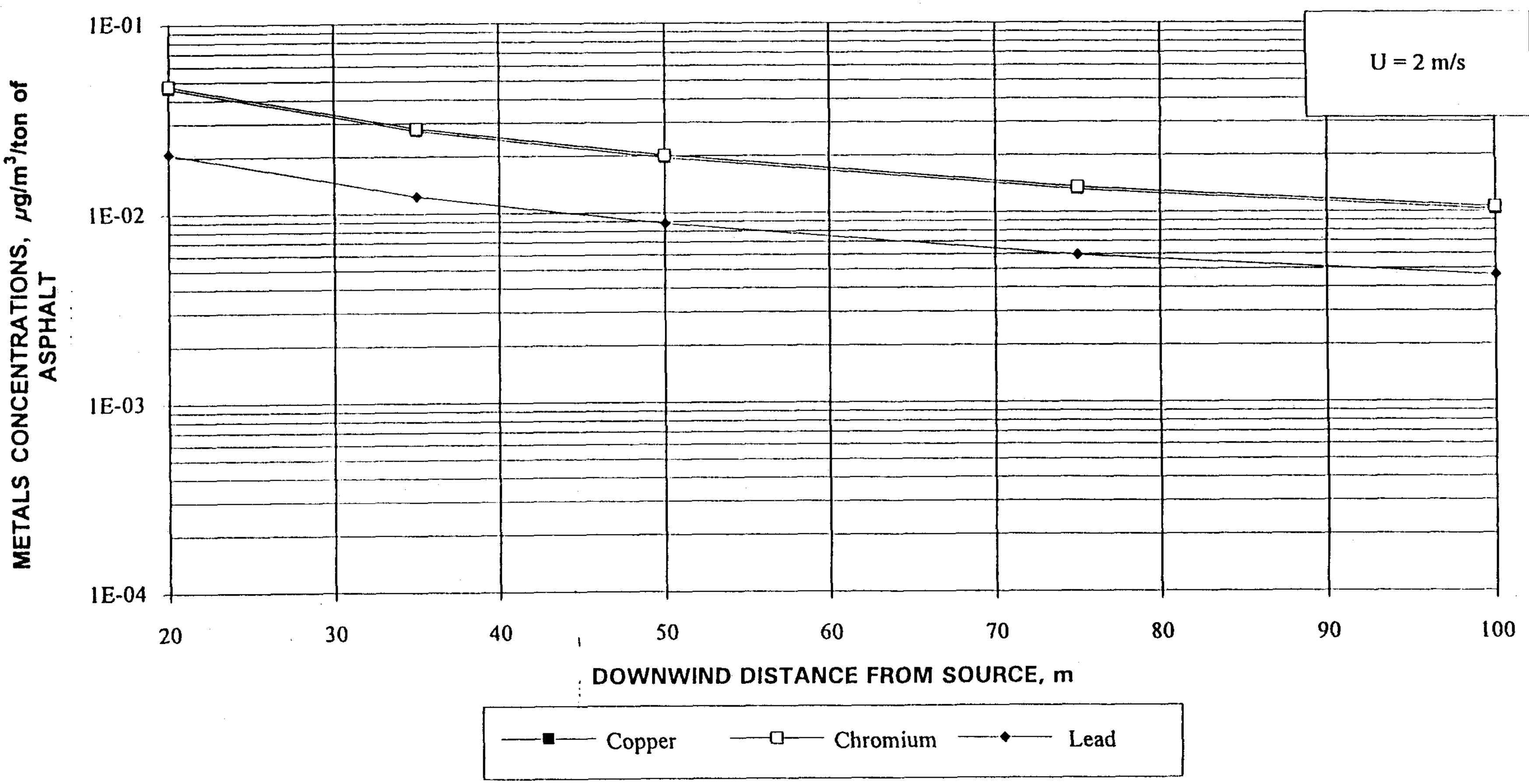


Figure 6-5. Normalized Curves of Metals Concentrations ($\mu g/m^3$) per Ton of Ground Asphalt Assuming a Uniform Velocity of 2 m/s.

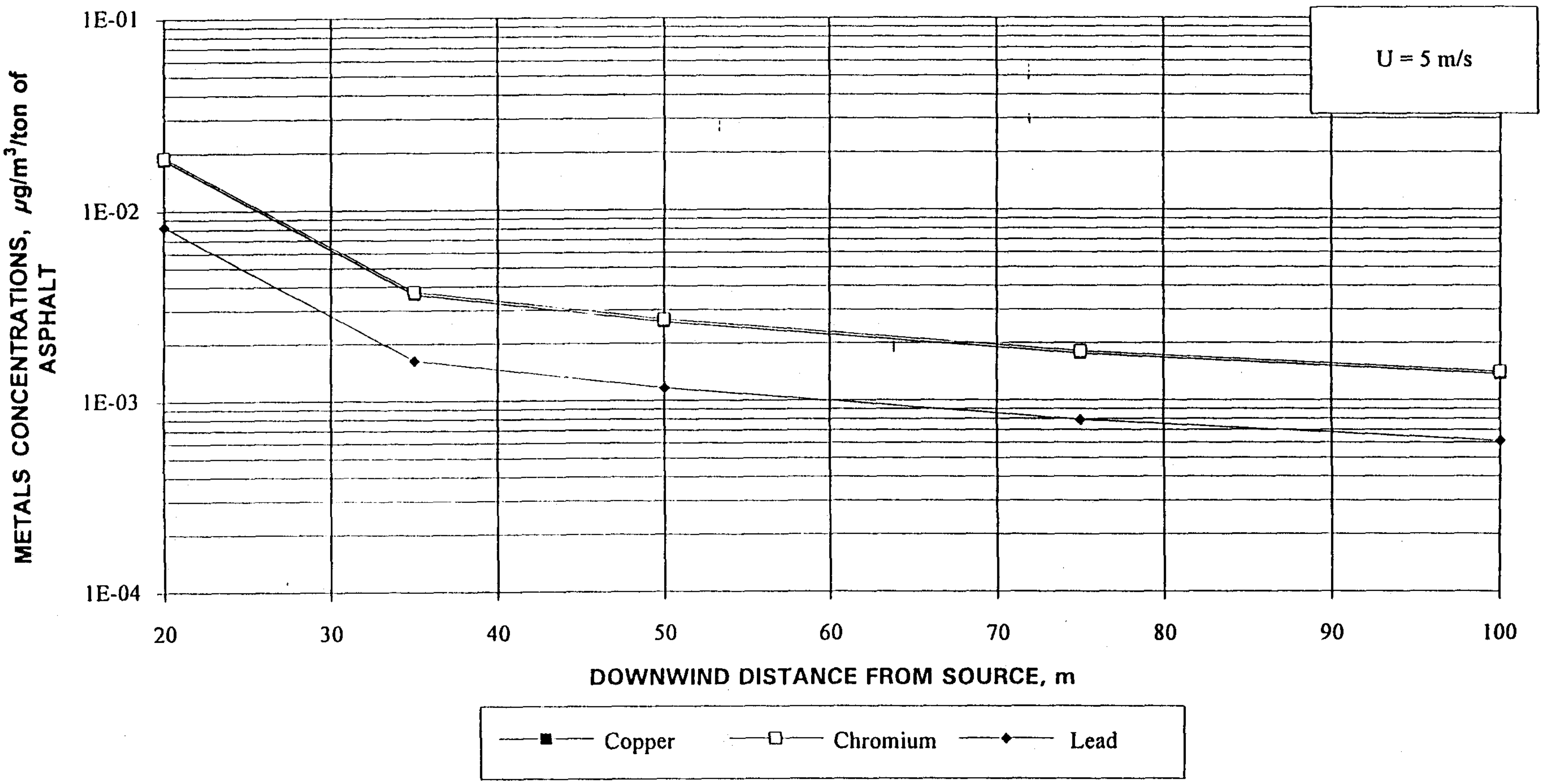


Figure 6-6. Normalized Curves of Metals Concentrations ($\mu g/m^3$) per Ton of Ground Asphalt Assuming a Uniform Velocity of 5 m/s.

Photo 6-3. Monitoring operations during the roadgrinding test at Hunters Point Annex.

6.5 Analysis of Excess Asphalt Piles From the Pilot-Scale Test

Approximately 12 tons of excess asphaltic concrete was generated during the demonstration for the asphalt containing untreated sandblasting grit and approximately 10 tons was produced during the demonstration run for the treated sandblasting grit. Because the excess asphaltic concrete was suspected to contain low levels of sandblasting grit, it was stockpiled at a remote location on the Reed and Graham yard and chemically analyzed for total WET-soluble Cu and Pb content. The results (Table 6-17) show low levels of metals, well below the TTLC and STLC thresholds.

Based on the chemical analyses, Bob McCormack of California EPA DTSC approved the transfer of the excess asphaltic concrete into the general scrap asphalt pile at Reed and Graham on March 17, 1992. The scrap asphalt was eventually ground and recycled back into fresh asphalt as coarse aggregate.

Table 6-17. Metal Analysis of the Excess Asphaltic Concrete Piles

Sample	Total (mg/kg)		WET-Soluble (mg/L)	
	Cu	Pb	Cu	Pb
Excess asphalt with untreated grit	110	20	1.8	<0.05
Excess asphalt with sulfide-treated grit	76	9.8	0.42	0.07

7.0 FULL-SCALE MIXING AND PLACEMENT OF ASPHALTIC CONCRETE

This section describes the process activities, test methods, and results, of the full-scale field demonstration of recycling spent sandblasting grit into asphaltic concrete. Preparation of the spent sandblasting grit was performed at HPA in June 1994. Use of the grit in paving operations occurred between June 1994 and October 1995.

7.1 Identification of a Plant for Full-Scale Field Demonstration

A commercial hot-mix asphalt paving contractor was needed to participate in the full-scale field demonstration. The first criteria for the paving contractor were a willingness and an ability to efficiently and responsibly handle most or all of the 4,000 yd^3 of spent sandblasting grit at HPA at a reasonable cost per ton. It was also desirable to minimize the transportation distance from HPA to the paving facility.

More than 40 candidate contractors were identified by review of business directories for the area around HPA. The candidates were contacted by phone to determine their interest in and ability to participate in the field demonstration. The 27 companies actually contacted but not chosen are listed in Appendix J. The contractor review process led to selection of the Orland Asphalt plant of Jaxon Enterprises, Inc. The Navy, Battelle, and Jaxon Enterprises completed an extensive program of regulatory interaction to obtain the permits required for the full-scale field demonstration. Regulatory compliance activities are described in Section 3.0.

The first step in preparing for the field demonstration was to develop and test a formulation for asphaltic concrete containing spent grit with the materials and processes used at Orland Asphalt. Orland Asphalt, in conjunction with Caltrans, prepared asphalt core samples containing HPA sandblasting grit. Two cores each were prepared containing 5% untreated grit and 5% sulfide-treated grit, and one core was prepared containing no grit to serve as a control. The cores were analyzed for total and WET-soluble Pb and Cu content by two different California-certified analytical laboratories, and the results, similar to those described in Tables 6-9 through 6-12, show compliance with Cal EPA recycling criteria.

7.2 Full-Scale Grit Handling, Screening, and Transport

Spent sandblasting grit was screened at HPA in preparation for transfer to Orland Asphalt. The screening operation was conducted from June 1, 1994 to June 14, 1994. Grit was collected by a vacuum truck (see Photo 2-3) from eight small piles (see Table 2-1) for processing along with grit from the untreated and sulfide-treated piles. The conveyors, screen, and air monitors were set up near the larger grit piles, as shown in the general arrangement plan view (Figure 7-1). Grit was removed from a pile with a front-end loader and dropped through a grizzly to remove oversize debris prior to loading on a conveyor (see Photo 7-1). The conveyor lifted the grit and discharged to the top of a screen. Oversize material rolled off the top of the screen while acceptable grit fell through to be collected by the second conveyor (see Photo 7-2). The screen was selected to pass material with a particle size under ½-inch. The second conveyor was periodically pivoted around the screen to distribute the screened grit. The configuration of the screening apparatus is shown in Figure 7-2.

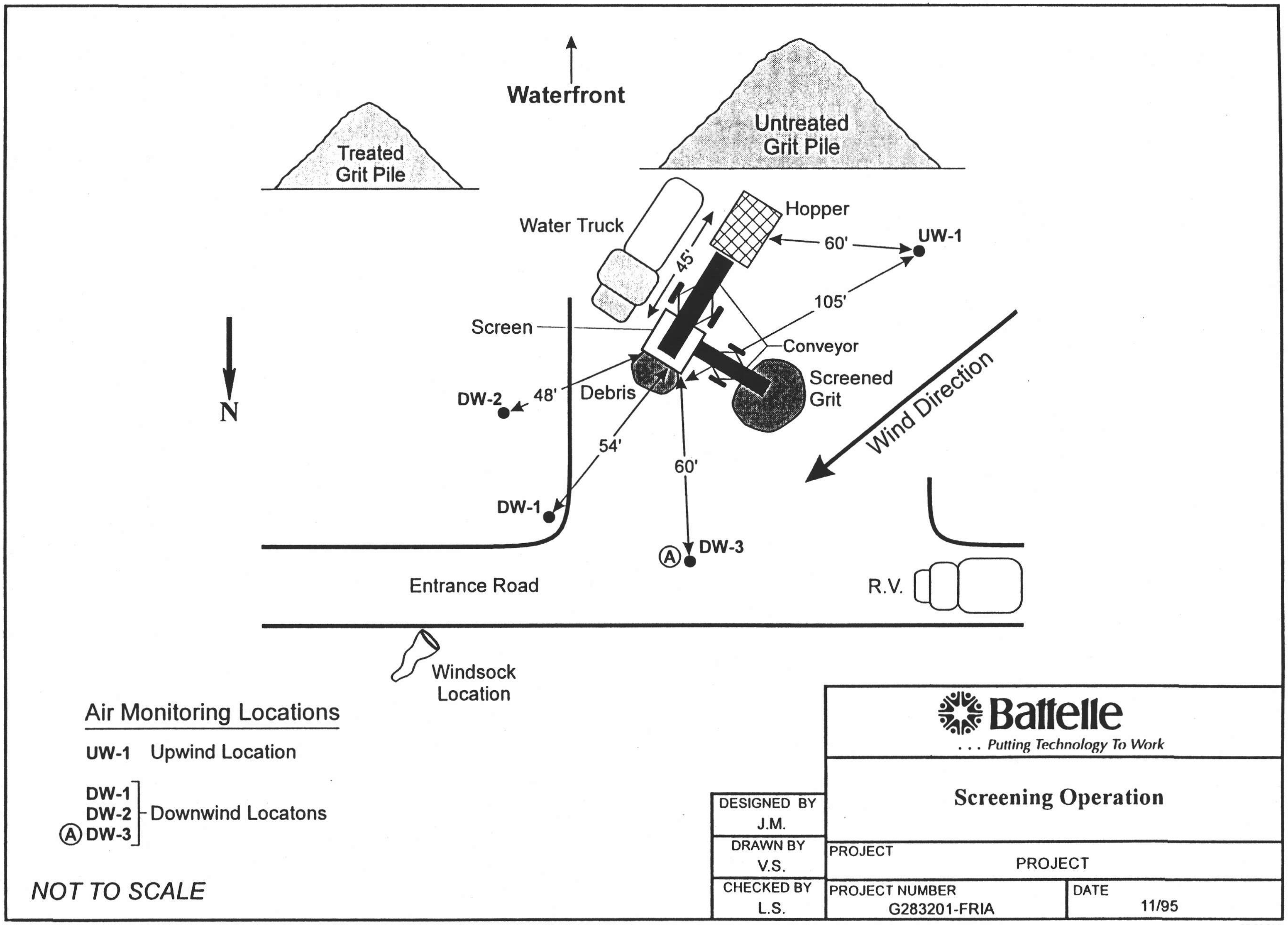


Figure 7-1. General Arrangement Plan View of the Sandblasting Grit Screening and Air Monitoring Equipment

Photo 7-1. Debris pile left over from screening operations (debris in foreground and screened grit in background).

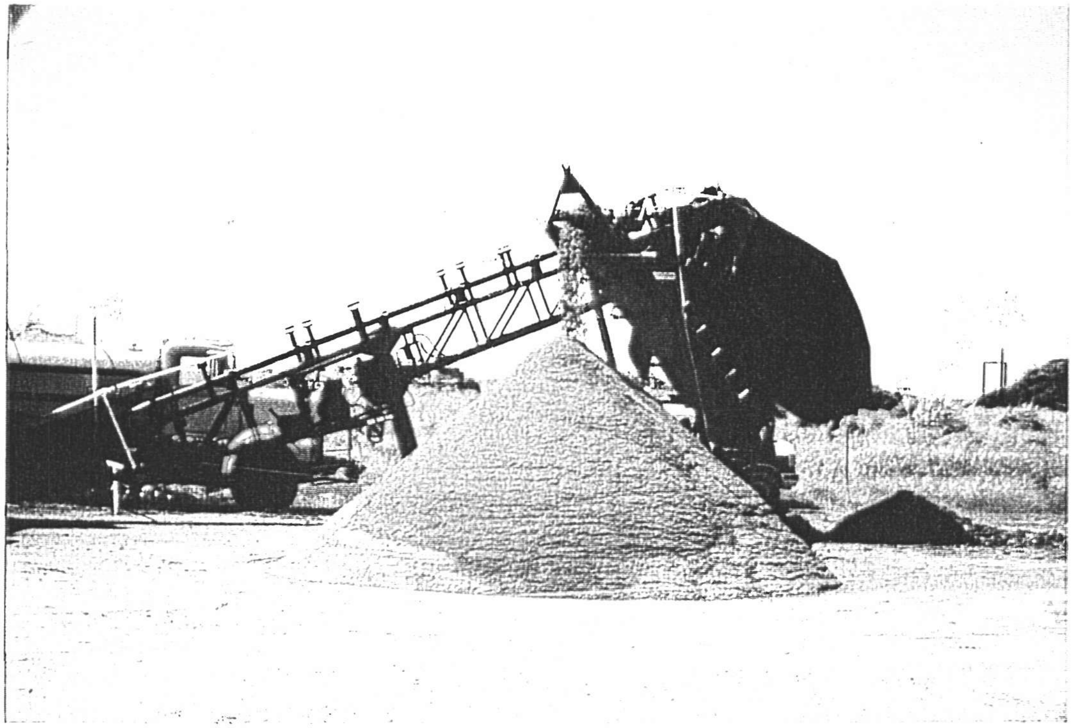


Photo 7-2. Screened grit emerging from the screening process.

Screening removed oversized clumps of spent grit as well as wood, cloth, and metal debris. The oversize material rejected by the screen was crushed using a sheep's foot roller to break up clumps and rescreened. The oversize material pile was crushed and rescreened several times to minimize the quantity of rejected oversize material. The resulting piles were then covered by tarps to minimize dust emissions (Photo 7-3).

Moving, screening, and crushing could produce fugitive dust. Water spray (Photo 7-4) was provided to minimize dust production, but monitoring was required to ensure that the preventative measures were sufficient (Photo 7-5). Miniature real-time aerosol monitor (MINIRAM) airborne particulate sample collectors were placed at one upwind and three downwind locations. In addition to the particulate samples, hand-held field screening instruments were used to periodically monitor for contaminants near the surface of grit areas recently exposed by the excavation. Periodic field surveys were performed for gross beta/gamma radioactivity, sulfide vapors, and volatile organic compounds (VOCs) (Photo 7-6).

In accordance with conditional use Permit #93-10 Item 28, issued by the Glenn County Planning Committee, spent sandblasting grit was not shipped into Glenn County until assurances by Caltrans or other public agencies were secured allowing use of the material in paving. The sandblasting grit was transported from HPA to Orland Asphalt in covered trucks. Each truck carried about 24.5 tons of grit. Photos 7-7 and 7-8 show the truck loading operations. The truck drivers were provided a documentation package describing the chemical composition of the grit, directions to Orland Asphalt, and a list of agencies to contact in case of an accident (Photo 7-9). An example transportation plan is shown in Appendix K.

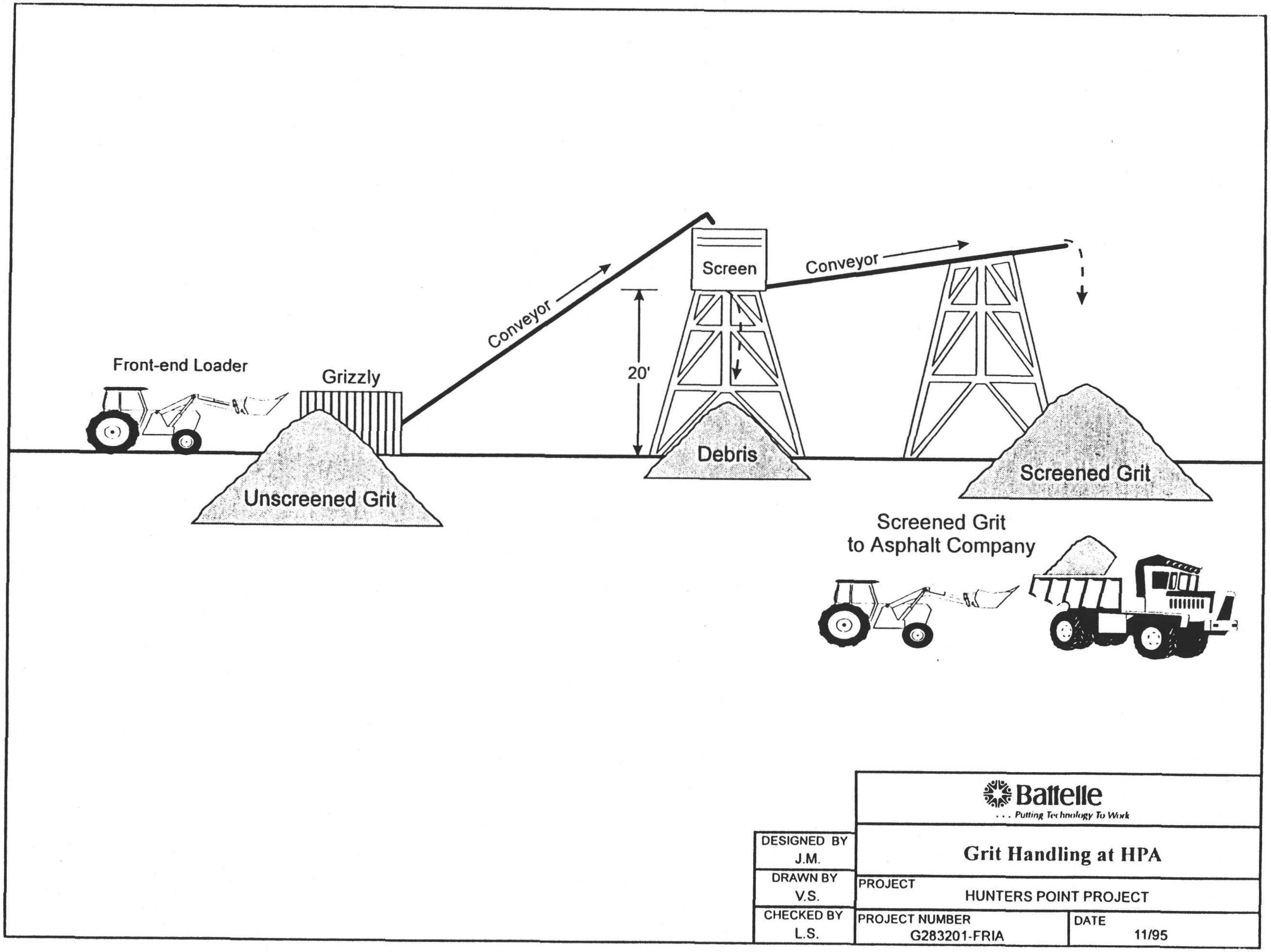


Figure 7-2. Layout of Sandblasting Grit Handling and Screening Equipment

Continue

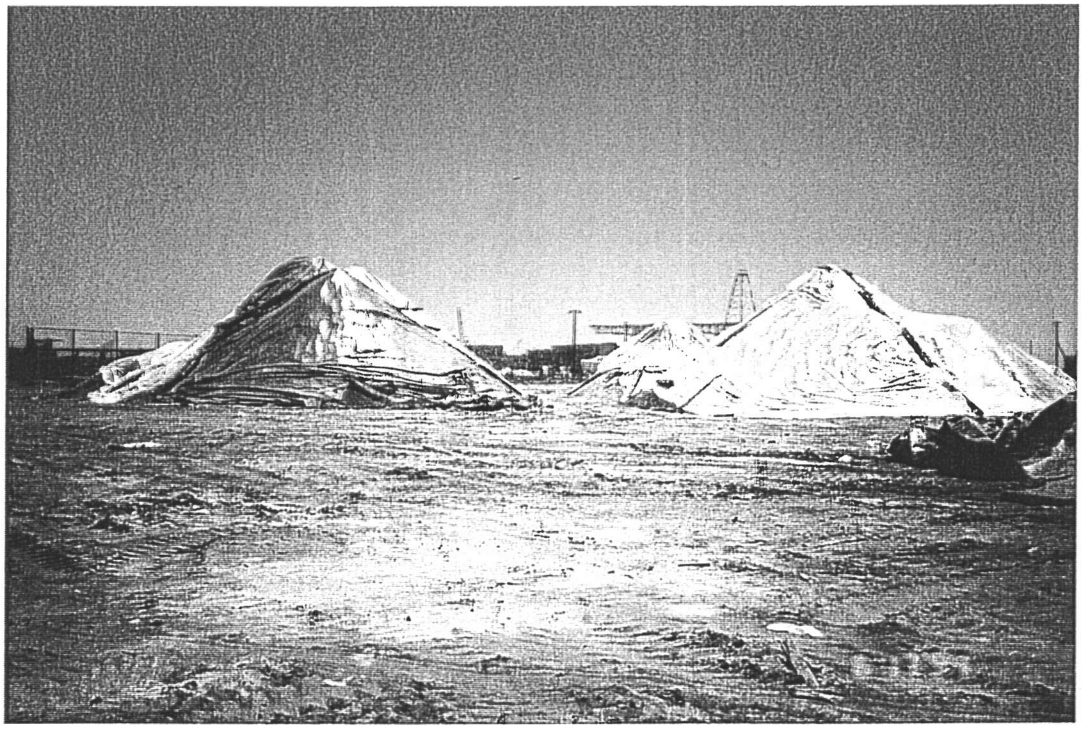


Photo 7-3. Covered grit piles awaiting transport to the asphalt hot plant.

Photo 7-4. Wetting the grit during screening operations to reduce dust emissions.